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POLLUTION OF LAKE SUPERIOR AND ITS TRIBUTARY BASIN-MINNESOTA-WISCONSIN-MICHIGAN. SESSION (2ND) (RECONVENED) PROCEEDINGS OF CONFERENCE HELD AT DULUTH, MINNESOTA ON AUGUST 12-13, 1970. VOLUME I

Federal Water Quality Administration
Washington, D. C.

13 August 1970

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PROCEEDINGS

LAKE SUPERIOR
MINNESOTA
MICHIGAN
WISCONSIN

Second Session (Reconvened)
Duluth, Minnesota
August 12-13, 1970

Volume 1

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CONFERENCE

In the Matter of Pollution of Lake Superior and its Tributary Basin-Minnesota-Wisconsin-Michigan

Reconvening of

SECOND SESSION

OF THE

CONFERENCE

IN THE MATTER OF POLLUTION OF LAKE SUPERIOR
AND ITS TRIBUTARY BASIN
IN THE STATES OF MINNESOTA, WISCONSIN, AND MICHIGAN

held in

Duluth, Minnesota

August 12-13, 1970

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The Second Session of the Conference on the Matter of Pollution of Lake Superior and its Tributary Basin reconvened at 9:30 o'clock on August 12, 1970, in the Great Hall, Radisson Hotel, Duluth, Minnesota.

It includes statements, discussions, and recommendations on criteria for the classification of the interstate waters and establishment of standards of quality and purity; enforcement, industrial waste and related information

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PROCEEDINGS

MR. STEIN: If any of you in the audience who are sitting here now wish to make a statement, I wish you would come up and see Mrs. Piere--would you raise your hand--come up here, register with her, and indicate how long your presentation will take, so we can get started. We would like to put the people who wish to make statements on first, so if you don't take this opportunity now, you will have to go and deal with the official agencies and the dischargers and you will have to wait until the end.

So I think for your convenience, if you wish to make a statement to the conference, please register with Mrs. Piere. We will start in about five or ten minutes after you have done so.

(RECESS)

OPENING STATEMENT

BY

MR. MURRAY STEIN

MR. STEIN: The conference is open.

This session of the Conference in the Matter of Pollution of Lake Superior and its Tributary Basin in the States of Minnesota, Wisconsin, and Michigan has been reconvened under the provisions of the Federal Water Pollution Control Act.

The first session of this conference was held on May 13 to 15, 1969. The conferees met in Executive Session on September 30 and October 1, 1969, and the second session first met on April 29 and 30 of 1970.

Both the State and Federal Governments have responsibilities in dealing with water pollution control problems. The Federal Water Pollution Control Act declares that the States have primary rights and responsibilities for taking action to abate and control pollution. Consistent with this, we are charged by law to encourage the States in these activities.

At the same time, the Secretary of the Interior is charged by law with specific responsibilities in the field of water pollution control in connection with pollution of interstate and navigable waters. The Federal Water Pollution Control Act provides that pollution of interstate or navigable waters which endangers the health or welfare of any persons shall be subject to abatement. This applies whether the matter causing or contributing to the pollution is discharged directly into such waters or reaches such waters after discharge into a tributary.

Opening Statement - Mr. Stein

Let me indicate that this conference has been established on the initiative of the Federal Government, and under Federal law we can only do so when the Secretary believes that a discharge in one State is endangering health or welfare of persons in another State.

The purpose of this conference is to bring together the State water pollution control agencies, representatives of the United States Department of the Interior, and other interested parties to review the existing situation, the progress which has been made, and to lay a basis for future action by all parties concerned, and to give the States, localities, and industries an opportunity to take any indicated remedial action under State and local law.

Parties to this conference are the official State water pollution control agencies of Minnesota, Wisconsin, Michigan, and the United States Department of the Interior. Participation in this conference will be open to representatives and invitees of these agencies and such persons as inform me that they wish to make statements. However, only the representatives of the State water pollution control agencies and the United States Department of the Interior constitute the conferees.

I would like to ask the conferees to introduce themselves, starting on my left. Would you start, Mr. Mackie?

MR. MACKIE: I am Donald Mackie, Assistant Secretary of the Department of Natural Resources in Wisconsin.

MR. FRANGOS: Thomas Frangos, Administrator, Division of Environmental Protection, Wisconsin Department of Natural Resources.

MR. VOGT: John Vogt, Director of the Division of Engineering, Michigan Department of Health, and a member of the Michigan Water Resources Commission.

MR. PURDY: Ralph Purdy, Executive Secretary of the Michigan Water Resources Commission.

MR. MAYO: Francis Mayo, Regional Director for the Federal Water Quality Administration, serving as the Federal conferee.

With me is Mr. Dale Bryson, Chief of our Lake Superior Basin office, Minneapolis.

MR. TUVESON: Robert Tuveson, Minnesota Pollution Control Agency.

MR. BADALICH: John Badalich, Executive Director of the Minnesota Pollution Control Agency.

DR. ANDERSEN: Howard Andersen, of the Minnesota Pollution Control Agency.

MR. STEIN: And my name is Murray Stein. I am from the Department of the Interior, Washington, have been designated by Secretary Walter J. Hickel as Chairman of the conference and am his representative.

Now a word about the procedures governing the conduct of the conference.

Conferees will be called upon to make statements and other participants will be asked to make statements. At the conclusion of each statement the conferees will be given an opportunity to comment or ask questions. This procedure has proven effective in the past in reaching equitable solutions.

We will not entertain comments or questions from the floor. However, you may have an opportunity to speak so hold your comments or questions until then so we can proceed in an orderly and effective manner. Anyone who feels that he has something to say that is pertinent or germane will be given a full opportunity.

At the end of all the statements, we will have a discussion among the conferees, probably in an Executive Session, and try to arrive at a basis of agreement on the facts of the situation. Then we will attempt to have a statement for the public giving you the conclusions of the conferees, if that is possible, and may have a summary of our discussions here.

Under the Federal law, the Secretary of the Interior is required at the conclusion of the conference to prepare a summary of it, which will be sent to the conferees.

We are having a verbatim transcript of the conference made by Mrs. Virginia Rankin. Mrs. Rankin is an independent contractor. We generally take several months before publishing the transcript. If you should want the transcript or any portion of it at an earlier time, please make your own arrangements with Mrs. Rankin.

When the transcript and summary is published, we will make these available to the States, and I would suggest that any parties wishing them get in touch with the State agency.

I would suggest that all speakers and participants other than the conferees making statements come to the lectern and identify themselves for purposes of the record. What we intend to do is call upon people who have indicated that they wish to make statements. At the noon recess or the first recess it is suggested that the municipalities and other public bodies from Minnesota may wish to get together with their Minnesota conferees--the Minnesota conferees have indicated that they would prefer this arrangement--to get your situation lined up for the Minnesota presentation.

Then we will call upon the State and Federal conferees to make statements. We will also hear at that time, directly or through the State agencies, from those responsible for the sources of pollution in various parts of the Basin or those the conferees feel might be responsible for discharges into the waters of the Basin.

In addition to that, we are going to have a Technical Committee report, which will deal with requirements for water quality in Lake Superior and which the conferees feel is essential to them if we are ever going to have a long-range program for protecting the lake.

With that, I would like to call on Dave Zentner, State President of the Izaak Walton League.

DAVID ZENTNER, PRESIDENT
MINNESOTA DIVISION
IZAAK WALTON LEAGUE OF AMERICA
DULUTH, MINNESOTA

MR. ZENTNER: Mr. Chairman, conferees.

My name is Dave Zentner. I reside in Duluth. I am President of the Minnesota Division, Izaak Walton League of America.

I would like to appear and briefly request this morning on behalf of the Minnesota Division, specifically with regard to Reserve Mining, an on-land disposition and cessation of tailings into Lake Superior. I would like to base that request briefly on the following points:

Current effects in the lake are said to be the promotion of algal bloom, causing the green water, elimination of fish food organisms and some fish, and that some of the fines remain in suspension and while suspended travel lake currents into interstate waters.

These above conclusions are all part of information presented to past sessions of the Lake Superior conference.

The second thing I would like to point out is that the long-term potential of this continual contribution will accelerate the four items above I just mentioned. The tailings impact is cumulative and they deteriorate at only the slowest rate.

The third point I would like to make this morning is that researchers have remarked that Lake Superior is unique in its water quality, that standards for it should be of the highest quality to insure nondegradation. From what we can determine, none of this is compatible with tailings disposition in the lake.

Reserve's basis for rejecting on-land disposal is based on, first of all, economics. They state costs in excess of $200 million for capital investment, high operational costs and replacement expenses. However, a study by the Bureau of Mines shows a very different picture, and to date we are aware of no independent study by competent people showing:

1. Thorough exploration of all on-land methods of disposition, both from the standpoint of economics and feasibility, that refutes or supports either Reserve or the Bureau of Mines.

The second basis for Reserve's concern over on-land disposition has been the question of the resource damage to the Lax Lake area, and we, too, are concerned about any further loss of resources. However, we question concern for Lax Lake while strenuous resistance meets all efforts by public agencies to alter the current method of contaminating Lake Superior.

1. We take all losses of our natural resources most seriously, but we are balancing a small lake against a freshwater sea.

2. We are measuring the loss of recreation to a few against the interest of millions.

3. Finally, there has been no final determination that Lax Lake has to be the disposal area.

Conclusion:

Once again we find the environmental well being of a resource important to many put into question by a resource user of a few members of society.

We repeat, and we realize that this enforcement conference cannot solve this problem, but I repeat that until the Congress legislates that the burden of proof of nondegradation lies with the resource users, public agencies will be hard pressed to effectively execute their discharge to protect those resources for all people.

Thank you very much.

(Applause.)

MR. STEIN: Thank you.

(The above statement follows:)

MINNESOTA DIVISION, IZAAK WALTON LEAGUE OF AMERICA

Statement to the Enforcement Conference on Pollution in the Lake Superior Basin, U.S.Department of the Interior, Federal Water Pollution Control Administration, Duluth, Minnesota, August 12, 1970

POINTS

I. Request on Land Disposition

(A) Current effects on Lake

1. Promotes algae bloom.
2. Causes green water.
3. Elimination of fish food organisms and some fish.
4. Fines remain in suspension and while suspended, travel lake currents into interstate waters.

(Above conclusions are all part of information presented to past sessions of Lake Superior Conference.)

(B) Long Term Potential

1. Contribution of 67,000 long tons daily will accelerate 1-4 above.
2. Tailings impact cumulative, they deteriorate at only the slowest rate.

(C) Application of standards to Lake Superior

1. Researchers have remarked that:
    a. Lake Superior is unique in its water quality.
    b. That standards for it should be of the highest quality to insure non-degradation.
    c. From what we can determine, none of this is compatible with tailing disposition in the Lake.

II. Reserve's basis for rejecting on hand disposal is based on:

(A) Economics

1. Stated costs in excess of 200 million dollars for capital investment.
2. High operational and maintenance costs.

- a. However, a study by the Bureau of Mines shows a very different picture and to date we are aware of no independent study by competent people showing:
    - 1. Thorough exploration of all on land methods of disposition both from the standpoint of economics and feasibility that refutes or supports either Reserve or the Bureau of Mines.

(B) Destruction of Lax Lake Area

- 1. We, too, are concerned about any further loss of resources, however:
    - a. We question concern for Lax Lake while strenuous resistance meets all efforts by Public Agencies to alter the current method of contaminating Lake Superior.
        - 1. We take all losses of our natural resources most seriously, but we are balancing a small lake against a fresh water sea.
        - 2. We are measuring the loss of recreation to a few against the interest of millions.
        - 3. Finally, there has been no final determination that Lax Lake has to be the disposal area.

CONCLUSION

III. Opinion of The League

Once again we find the environmental well being of a resource important to many put into question by a resource user of a few members of society.

We repeat that until the Congress legislates that the burden of proof of non-degradation lies with the resource user, public agencies will be hard pressed to effectively execute their discharge to protect those resources for all of the people.

MR. STEIN: Are there any comments or questions?

Mr. Zentner, I don't know that the position that you state is quite as dismal as you might indicate.

I think I agree with what you say, but we have to recognize that the States, at least, have a permit system and that the Federal Government, through the Corps of Engineers, the Federal Power Commission, the Atomic Energy Commission, also has a permit system.

A question that has come up rather frequently in recent months in my experience is that the power industry is putting out wastes which some people feel will raise the temperature of the receiving waters too high. Some of these amount almost to 18 or 20 degrees. I have had numerous discussions in specific cases with representatives of the power companies and they always ask that the Government prove that their waste discharge is going to harm the waters--to give them conclusive proof. I am always a little startled by that, because they are looking for a permit. I say, "I didn't ask you to put the plant up there. How about your showing me that what you are going to do is not going to hurt the waters?"

And I think possibly if more of us took that approach when we exercise our permit-issuing process that possibly we can find that we have existing legislation and techniques on the books to handle this without necessarily waiting for some more.

Thank you, Mr. Zentner.

May we have Mr. B. J. Cismowski.

B. J. CISMOWSKI
SAVE LAKE SUPERIOR
DULUTH, MINNESOTA

MR. CISMOWSKI: Mr. Chairman, ladies and gentlemen.

I am Mr. B. J. Cismowski, 1532 Eighth Avenue East. Too bad those seats aren't filled up, but it can't be helped.

Now, this pollution of Lake Superior has been going on too long, as far as I am concerned. Maybe you feel the same way about it. We have a freshwater lake out here; we use it for drinking water, and it is to the interest of the people of Duluth and the people who use the water.

I may get criticized here, I don't know, but I hope not. This lake has got to be preserved. They say, "We will haul the tailings out of Duluth." They will try; they will try anything.

Something has got to be done. Even by letting the water come into the plant and out of the plant causes pollution. The debris will be with the water.

If I wasn't interested in this I would never be up here speaking, but I take interest in Duluth and the water of Duluth, and I hope other people feel the same as I do about this. I have lived in Duluth all my life and I wish to remain here, and I want to see Duluth water be as it is.

It is natural, the lake is natural, and help me if we have this lake polluted. They say, "Maybe. We don't think so." They had better know so.

I hate to get up here and make a report of this kind. It takes guts to do it. But I will tell you one thing, I will back up the citizens of Duluth and I want our committee here to be with us, because this lake has got to be preserved, not for us, but the future generation. It kind of makes me mad to see things like this happen.

There have been other things happening where they polluted the waters. We have got smart men in this country, but they can't see through it before it happens.

Now, let's take something into consideration before it happens. And I thank you a lot.

(Applause.)

MR. STEIN: Thank you very much.

MR. CISMOWSKI: You are entirely welcome.

MR. STEIN: May we have Mrs. Arlene Harvell.

MRS. ARLENE HARVELL, EXECUTIVE DIRECTOR
SAVE LAKE SUPERIOR ASSOCIATION
MINNESOTA, WISCONSIN, MICHIGAN
TWO HARBORS, MINNESOTA

MRS. HARVELL: Thought I would give you boys something to drink this morning.

I am Mrs. Arlene Harvell, the Executive Director of the Save Lake Superior Association.

Gentlemen, at the last reconvening of this conference the Save Lake Superior Association called your attention to sewage treatment facilities for existing and planned shoreline communities, to disposal of taconite tailings, to pollution by cargo vessels, and to the indiscriminate shoreline development of the Lake Superior Basin.

Addressing ourselves to much the same topics, we now ask for consideration of the following:

1. Regarding municipal sewage treatment facilities, our attention has been directed to the shortage of qualified individuals available to aid our communities in the evaluation of needs and the selection of comprehensive plans for sewage treatment. The financial involvement is major, and the probabilities of "oversell" to our small communities are strong.

We would, therefore, recommend that either the individual States present here, the conference itself, or the Federal Government, or any combination of these parties, seek to establish a task force of qualified personnel who would be available to assist municipalities in evaluating their needs and the designs of bidding engineering firms.

2. Save Lake Superior Association reaffirms its position of total on-land disposal of taconite tailings emanating from the Reserve Mining Company, E. W. Davis Works, Silver Bay, Minnesota. We have followed the court action

in Lake County District Court, Two Harbors, and feel that our position has received overwhelming scientific support. Even the stumbling block of economic feasibility was virtually destroyed there. In the light of such evidence, it would appear absurd for this conference, and for you conferees, to seriously consider any proposals by Reserve Mining Company other than those for total on-land disposal.

We again ask for the immediate revocation of tailings disposal permits to Reserve Mining Company and recommend the granting of minimum time for changeover to on-land disposal.

3. Concerning the pollution from small watercraft, as well as from major lake carriers, we ask that this conference set deadline dates for compliance in halting the discharge of sewage, bilge water, trash, and dunnage. We further ask for immediate action to initiate the construction and operation of facilities in all Lake Superior ports to

provide these services. In this regard also, we ask for a full report and evaluation of existing local, State, and Federal port and harbor facilities in the Lake Superior Basin.

4. In updating your "Appraisal of Water Pollution in the Lake Superior Basin" regarding the status of industrial dischargers in Minnesota, we request the inclusion of Abex Corporation, Two Harbors, Minnesota. At present they have a 36-inch effluent pipe with intermittent discharge of the material, sample I have placed before you. According to our own studies, this is in violation of State standards, and as this conference has previously stated, anything added to this lake is mixed in the entire lake. It, therefore, becomes your concern also.

In addition, I would like to make an attachment. I will give you a copy of what I have just said, but I would like to add something.

On April 29, 1970, we were to have submitted a petition from our Chapter of Save Lake Superior at the University of Wisconsin, Stevens Point.

Unfortunately, their petition arrived one day too late, and so it was decided to delay its presentation until this reconvening here. There are 189 signatures on this petition. It calls for revocation of Reserve's permit and the stopping of dumping tailings into Lake Superior.

(The petition referred to is marked Exhibit 1 and is on file at the FWQA Headquarters in Washington, D.C., with a copy on file at the FWQA Regional Office in Chicago, Illinois.)

Also, you may have recently read about the suburban Washington, D.C., housewife who sent a petition with 5,000 signatures on it from the upper peninsula of Michigan asking for President Nixon's speedy intervention to stop Reserve Mining Company's using Lake Superior as a private dump for tailings. Today we are sending an additional 2,000 signatures to be added to her petition.

The signatures we collected were done so with the understanding that a copy of them would be submitted to this conference. And I have that copy here.

Are there any questions?

MR. STEIN: What permits are you talking about? Who has issued those permits?

MRS. HARVELL: We are speaking of the permits of the Reserve Mining Company and these would be all three, the Conservation Department--

MR. STEIN: No.

MRS. HARVELL: --or the two State permits plus the U. S. Army Corps of Engineers permit.

MR. STEIN: And you want us to transmit your request to them?

MRS. HARVELL: Certainly. We would like you to take it into consideration in your--submit the--

I am sorry, I don't believe I understood your question, Mr. Stein.

MR. STEIN: Well, the point is, these conferees are not the operative agency in issuing or denying those permits.

MRS. HARVELL: No, but they do have that matter under their consideration, is that right?

MR. STEIN: Yes. But you see, if someone were to take action on the permits one way or the other, it would not be the conferees here.

MRS. HARVELL: It would not be your action, but it would be your recommendation, sir.

MR. STEIN: Right. Right.

MRS. HARVELL: Are there any further questions?

MR. STEIN: Thank you very much, Mrs. Harvell.

(Applause.)

(Which statement, with attachment, follows:)

Save Lake Superior Association

SAVE LAKE SUPERIOR SLSA

TO PREVENT THE POLLUTION OF LAKE SUPERIOR

Statement to the Conference on pollution of Lake Superior and its tributary basin (Minnesota - Wisconsin - Michigan) August 12,13, 1970, Radisson Duluth Hotel, Duluth, Minnesota.

Gentlemen: At the last reconvening of this conference, the Save Lake Superior Association called your attention to sewage treatment facilities for existing and planned shoreline communities, to disposal of taconite tailings, to pollution by cargo vessels and to the indiscriminate shoreline development of the Lake Superior Basin.

Addressing ourselves to these same topics, we now ask for consideration of the following:

1. Regarding municipal sewage treatment facilities, our attention has been directed to the shortage of qualified individuals available to aid communities in the evaluation of needs and the selection of comprehensive plans for sewage treatment. The financial involvement is major. The probabilities of "oversell" are strong.
   We would therefore recommend that either the individual states present, the conference, the federal government or any combination of these parties seek to establish a task force of qualified personnel who would be available to assist municipalities in evaluating their needs and the designs of bidding engineering firms.

2. SLSA reaffirms its position of total on-land disposal of taconite tailings emanating from the Reserve Mining Co., E.W. Davis Works, Silver Bay, Minn. We have followed the court action in Lake County District Court, Two Harbors, and feel that our position has received overwhelming scientific support. Even the stumbling block of economic feasibility was virtually destroyed. In the light of such evidence it would appear absurd for this conference to seriously consider any proposals by Reserve Mining Co., other than those for total on-land disposal.
   We again ask for the immediate revocation of tailings disposal permits to Reserve Mining Co. and recommend the granting of minimum time for changeover to on-land disposal.

3. Concerning the pollution from small water craft as well as from major Lake carriers, we ask that this conference set deadline dates for compliance in halting the discharge of sewage, bilge water, trash and dunnage. We further ask for immediate action to initiate the construction and operation of facilities in all Lake Superior ports to provide these services. In this regard also, we ask for a full report and evaluation of existing local, state and federal port and harbor facilities in the Lake Superior Basin.

4. In updating the " Appraisal of Water Pollution in the Lake Superior Basin ", regarding the status of industrial dischargers in Minnesota, we request the inclusion of Abex Corporation, Two Harbors, Minnesota.

Respectfully submitted,

Mrs Arlene Harvell

Mrs.Arlene Harvell
Executive Director
Save Lake Superior Association
Minnesota, Wisconsin, Michigan

Attachment to Statement to the Lake Superior Enforcement Conference
August 12 - 13, 1970 by the Save Lake Superior Association

Gentlemen: On April 29, 1970, we were to have submitted a petition from our Chapter at the University of Wisconsin, Stevens Point. Unfortunately, the petition arrived one day too late so it was decided to delay its presentation until the reconvening of this session. 189 signatures.

. . .

Also, you may have read about the suburban Washington D.C. housewife who recently sent a petition with 5,000 signatures on it, asking for President Nixon's speedy intervention to stop Reserve Mining Co, from using Lake Superior as a private dump for taconite tailings. Today, we are sending an additional 2000 to be added to Her petition.

The signatures we collected were done so with the understanding that a copy of them would be submitted to this Conference.

MR. STEIN: Stan Ulrich.

GRANT J. MERRITT
LAKE SUPERIOR TASK FORCE CHAIRMAN
MINNESOTA ENVIRONMENTAL CONTROL CITIZENS ASSOCIATION
MINNEAPOLIS, MINNESOTA

MR. MERRITT: Mr. Chairman, my name is Grant Merritt. Conferees and ladies and gentlemen.

MECCA would like, if it is agreeable to the conferees, to divide its presentation here today. And first of all we would like to introduce one of three law students from the University of Minnesota who are participating in a study taking place this summer--it has been under way for over a month now--of the Reserve Mining controversy. The three students are going into their second year at the University of Minnesota. Their names are:

Miss Deborah Hedlund, from Minneapolis;

Timothy Berg from southern Minnesota, Stewartville; and

Stanley Ulrich, from Minneapolis.

We would ask that later on in the session today we be given the opportunity to present evidence on behalf of MECCA.

But the three law students that I mentioned are sponsored by the group known as the Northern Environmental Council, which represents some 22 or 23 conservation organizations throughout the upper midwest, north central States. The students are actually financed by several of the groups that participate in Northern Environmental Council, such as MECCA, Save Lake Superior Association, Clear Air Clear Water Unlimited, and several other individuals and organizations.

It is with a great deal of pleasure that I introduce at this time, to present the partial report on behalf of the three law students, Mr. Stanley Ulrich, of Minneapolis.

Stan.

MR. STEIN: While Mr. Ulrich is coming up, I know Mrs. Harvell indicated that there was a housewife who collected petitions and Mr. Burt Atwood came up with an article. I read the lead sentence in the article. It says, "Meet Mrs. Verna Mize, a soft-spoken, middle-aged suburban Washington housewife, who loves Lake Superior," and so forth, written by Albert Eisele, whom you probably all know and I know. I guess I am going to have to talk to Eisele, because I have met Mrs. Mize in my office when she came in with those 5 or 10 thousand petitions, and I don't know where he got that "soft-spoken." (Laughter.)

Mr. Ulrich.

STANLEY ULRICH
UNIVERSITY OF MINNESOTA
FOR THE
NORTHERN ENVIRONMENTAL COUNCIL
MINNEAPOLIS, MINNESOTA

MR. ULRICH: I am Stan Ulrich, of Minneapolis, and I will be presenting the statement of the Northern Environmental Council.

During the 1947 hearings before the Minnesota Water Pollution Control Commission, witnesses for Reserve Mining Company stated that tailings would not be observable for more than one mile from the plant. According to the study, "Effects of Taconite on Lake Superior--1970" first issued in April, and later revised and supplemented, the National Water Quality Laboratory personnel have observed green water attributable to Reserve's operations as far south as the Crow River, about eighteen miles from the plant.

At the 1947 hearings, Reserve claimed that the amount of tailings that were to be dumped into Lake Superior would be insignificant compared to the amounts of materials carried into the lake by the rivers and streams. Based on data from the U. S. Geological Survey, the amount of sediment discharged into the lake each year by tributary streams in Minnesota is about equal to the quantity of taconite tailings discharged each day from the plant at Silver Bay.

Witnesses for Reserve said in 1947 that there would be no soluble materials in the tailings, and the President of Reserve reaffirmed this belief at the first Federal Enforcement Conference. In the National Water Quality Laboratory's recent study we find that an amount equivalent to approximately 160,000 pounds of dissolved solids is being added to Lake Superior by Reserve's discharge each day.

At the first Federal Enforcement Conference on May 14, 1969, Edward Furness, President of Reserve, stated that tailings are "inert, inorganic, insoluble in Lake Superior, and biologically inactive." The National Water Quality Laboratory has found that tailings are biologically active at concentrations of approximately one milligram per liter, a concentration expected to occur over a significant area of Lake Superior.

On June 5, 1947, at the permit hearings, H. S. Taylor, who represented Oglebay-Norton, the managing agents for Reserve, testified that no chemicals whatsoever would be added to the lake. Since the issuance of the permit, Reserve has admitted to the Corps of Engineers that it dumps substantial quantities of calcium chloride into Lake Superior. For example, in the winter of 1966-1967, 2490.89 long tons were dumped, and the next winter 1777.65 long tons were dumped. At the recent trial in Two Harbors, Kenneth Haley, Manager of Research and Development at Reserve, admitted that they dumped sulphuric acid into the lake and that they have dumped many times the amount of chemicals that a sewage treatment plant puts into the lake.

This brief history indicates that in some cases Reserve has been relatively consistent over the 23-year period since 1947, even when they were confronted with strong conflicting evidence. In other cases Reserve has been forced to make admissions contrary to its earlier position. The result is that Reserve was wrong in 1947, and they are wrong now, whether by reason of innocent mistake, inadequate research, misrepresentation, or occurrence of unforeseen conditions.

It is important that we recognize that Reserve is to bear the risk of changed conditions. Commissioner Wilson warned Reserve of this fact in 1947:

> "And you understand that if the permit should be granted and the discharge of waste from this plant should result in damaging consequences not contemplated, that the responsibility would be on your company or on the applicant to take whatever action might be necessary to remedy those conditions."

H. S. Taylor, of Oglebay-Norton, responded:

> "Why, yes, we can stand that risk in any event. We have to take certain risks."

Now is the time for Reserve to make a virtue of consistency by fulfilling this obligation undertaken 23 years ago.

However, Reserve pleads that there is no alternative which is financially feasible. They base this claim upon an accounting procedure by which their profit per ton is determined to be $1.58, and their rate of return on investment equals 4.41 percent. This analysis is improper.

A letter from the Internal Revenue Service to Reserve, dated December 1, 1961, introduced at the Two Harbors trial, explicitly states that Reserve is a captive company of Republic Steel and Armco Steel. This means that these parent companies receive all the profits, bear all the losses, own the mineral rights, have direct control over Reserve's ore production, and receive the 10 million tons of ore Reserve produces each year at cost. Therefore, the profit per ton claimed by Reserve is completely hypothetical, since Reserve retains none of what it makes.

A correct evaluation of the economic feasibility of an alternative method of disposal must evaluate Armco's and Republic's ability to fund the project, since they take all the profits and losses and all tax deductions are transferred to them.

Dr. Glenn Berryman, University of Minnesota Accounting Professor, on leave with Touche Ross and Company, Certified Public Accountants, completed an analysis of the financial feasibility of putting into operation an alternative disposal method for the

Minnesota Pollution Control Agency. He also analyzed the cost of closing the Silver Bay plant. Dr. Berryman treated Reserve as an independent company for the purpose of comparing his fund flow data (funds available) to Reserve's approach of profit per ton. Funds available analysis is a method of measuring the company's financial situation which gives a more accurate picture of Reserve's ability to install alternative means of tailings disposal than does Reserve's method of profit analysis.

Dr. Berryman, using methods of analysis more acceptable to accountants than profit analysis used by Reserve, found that there would be $2.19 per ton available, as opposed to the $1.58 per ton profit figure used by Reserve. Using the figures of $74,132,000 in capital costs, and $12,490,000 in average annual cost of Reserve's alternative #2--"Disposal of Tailings Near Taconite Mine"--Berryman established that Reserve would still be operating at a profit after adoption of even so expensive a plan. Obviously, a less expensive plan would be even more favorable. He found that the adjusted rate of return on the funds provided by Armco and Republic after installation of the alternative disposal method would be 19.7 percent after taxes, based on a three-year average, 1967 to 1969. He also found the rate of return on total assets, excluding amounts due from Armco and Republic, over the 3-year period to be 7.04 percent. Even this lower figure is higher than the 10-year average returns for the parent companies: Republic at 5.5 percent and Armco at 6.3 percent.

We noted that Dr. Berryman arrived at a higher rate of return after installation than Reserve's 4.41 percent figure, which represents their computation of rate of return before installation.

Reserve has threatened to close down the plant if required to adopt an alternative means of tailings disposal. In actuality this is a completely unreasonable alternative.

There are two reasons why Reserve will not shut down. First, Republic and Armco depend on Reserve for 10 million tons of ore each year. Major decisions concerning Reserve's operations are made by an 11-man Board of Directors, five each from the parent companies and one from Reserve. Therefore, the decision would depend on Armco and Republic's ore needs rather than Reserve's pretended financial situation.

Dr. Pfleider of the University of Minnesota

School of Mines testified in the Two Harbors trial that to close Reserve would necessitate the cost of opening up new ore fields since all currently operating ore fields are committed. The importance of all this is that the parent companies and Reserve are bound together for the foreseeable future.

The second reason Reserve will not close down is this. Even if alternative means of disposal were to cause Reserve to operate at a hypothetical slight loss, or no gain, the plant would not shut down. This conclusion follows from the calculation of Dr. Berryman that the estimated partial net outlays required to close all facilities about December 31, 1971, would be equal to $82,121,000. Obviously, several alternative methods of disposal are less expensive than the cost of the threatened closing. In fact, Dr. Berryman found that Reserve could operate at a $5 million deficit for 40 years, Reserve's estimate of the life of its ore body, and still be financially better off than it would be after expending the money required to close the plant. (See appendix for further details.)

It is, therefore, evident to all observers that there has been little progress in the effort to end Reserve's discharge into Lake Superior. This may be surprising considering the number of alternative routes to reach the desired end: The trial between the Minnesota Pollution Control Agency and Reserve in Two Harbors; the pending permit revocation hearings to be held by the State; the Federal Enforcement Conference now in its second session; and the pending Corps of Engineers permit revocation proceeding.

Under the Memorandum of Understanding between the Secretary of the Interior and the Secretary of the Army dated July 13, 1967, the Department of the Interior is to review the environmental effects of dredging, filling, and excavation carried on under permits issued by the Corps of Engineers. The Memorandum speaks of the two Departments' joint responsibilities "to improve water quality through the prevention, control, and abatement of water pollution from ... federally licensed activities," and it establishes a policy of "full coordination and cooperation ... on the above responsibilities at all organizational levels."

Pursuant to this understanding, a study was undertaken by the Interior Department and in 1968 its recommendations were received by the Corps of Engineers. However, before they could or would act upon it, Secretary

Udall called the first Federal Enforcement Conference, and the Corps was requested to wait for further evaluation of the facts and for "definitive recommendations" from the Department of the Interior.

The controversy surrounding the Interior report, and the lack of definitive recommendations coming out of this conference, have put the Corps in a position where it is expected to make a decision, but it is not getting the necessary support and influence from the Department of Interior by way of concrete recommendations. Up to this point, all the conference has recommended which is germane to Reserve's situation is that the plant be kept under continuing surveillance and that the company submit engineering studies for alternative disposal methods. The first task has been performed. Reserve has responded to the second by introducing a technically anemic but financially voluptuous progress report.

This conference seems to have taken the view that there must be a dead body floating in Wisconsin waters whose death can be attributed to taconite tailings from Reserve's plant before the conference will have jurisdiction. While we do not necessarily agree with this limited view of interstate jurisdiction, we also realize that it is rather late to press for an alteration of the adopted view.

From all this there would appear to be two reasonable alternatives now open to the conference which would bring about the desired result:

1) A definitive finding that Reserve's discharge constitutes pollution which endangers the health or welfare of persons in another State can be made on the basis of the testimony of Dr. Donald Mount, Director of the National Water Quality Laboratory, entered into the record of the second Enforcement Conference held last April. At that time Dr. Mount said that he would expect concentrations of tailings which accelerate bacteria growth rates to occur in Wisconsin waters. His testimony was based on the study mentioned previously, entitled "Effect of Taconite on Bacterial Growth" included in the study "Effects of Taconite on Lake Superior." In this study we find that biologically active concentrations of tailings can be expected to occur over a "significant area of the lake."

The National Water Quality Laboratory and the FWQA are now completing studies to further corroborate this finding, which we understand will be submitted in approximately two weeks. The next logical step is for this conference to assert jurisdiction under the last part of Section 10(d)(1) of the Federal Water Pollution Control Act, as amended, and act accordingly.

2) The Corps of Engineers considers the following criteria relevant for revalidation of existing permits: Nevigation, water quality, water supplies, fish and wildlife habitat and food supply, aesthetics, economy of the area, and availability of ferrous metals for commercial purposes and national defense. We have shown that because of available alternatives there is no threat to the economy of the area, nor is there any threat to commercial and military uses of ferrous metals. It is also evident that the discharge is having an adverse effect on water quality and aesthetics. Fish habitat and food supply have been directly affected in the local area of the discharge of tailings, and to an undetermined extent there may be indirect effects on fish throughout the western end of the lake.

General Fred Clarke, Chief of the Corps of Engineers, told the Duluth press after his meetings with the various parties in the controversy on July 29 that the Corps of Engineers could be expected to make its decision on revalidation within a year. It is the responsibility of this conference to aid the Corps in that task by concluding that Reserve is polluting and that Reserve has the financial means to construct a feasible alternative method of disposal which would prevent any further degradation of Lake Superior. Further the conference should recommend that the Corps of Engineers renew Reserve's permit conditionally for such time as is necessary for construction of on-land disposal facilities.

End of statement.

(Appendix to the above statement follows.)

RESERVE MINING COMPANY

ESTIMATED PARTIAL NET OUTLAYS TO CLOSE RESERVE MINING COMPANY'S OPERATIONS ABOUT DECEMBER 31, 1971

DESCRIPTION		Payments (receipts) (amounts in thousands)
1. First mortgage bonds - balance December 31, 1969	$152,222	
Less installments payable in 1970 and 1971	16,711	$135,511
2. 5-1/2% promissory notes of Silver Bay Housing Corporation, guaranteed by Reserve Mining Company and each of the participants:		
Principal outstanding December 31, 1969 (no reduction in principal is assumed for 1970 or 1971)	1,963	
Less tax benefit	942	1,021
3. Tax benefit arising from uncollectibility of First Mortgage Notes Receivable		(4,611)
4. Tax benefit arising from abandonment of property, plant and equipment		(49,800)
Estimated partial net outlays required to close all facilities about December 31, 1971		$ 82,121

The above listing is not all inclusive in that it does not include benefits or outlays such as the following for which no estimates were available:

a. Shutdown costs

b. Pensions, relocation payments and severance pay for employees terminated or relocated

c. Realization from sale of properties

d. Benefits from moving equipment to other sites

MR. STEIN: Are there any comments or questions?

I have several.

One, I see these references to green water. Is there an objection to green water? And if there is, what is it?

MR. ULRICH: Are you asking me if there is--

MR. STEIN: Yes, I am asking you about that. You say it creates green water. Is there objection to something that creates green water? And if there is an objection, what is the basis?

MR. ULRICH: Well, Lake Superior is renowned for its deep blue waters, I am told. If you have been up along the north shore when Reserve is dumping its tailings, which is all the time, you will notice that there is generally a very bright band of green water proceeding from the plant down to as far as the Crow River, according to the National Water Quality Laboratory study.

I suppose it depends on whether you like blue better or green better, but we do know that the natural situation in the lake is blue.

As far as the report goes, the object of the reference to green water is that in 1947 Reserve said there would be no visible effects of tailings outside the permit area. We mention green water to show that Reserve was wrong and we think this establishes a--it is sort of a *modus operandi* in some areas for Reserve.

MR. STEIN: What do you mean by that? You mean to be wrong?

MR. ULRICH: Well, not by design, but we have pointed out several examples in which Reserve made misrepresentations in 1947, they were granted their permit based upon these representations. Things have changed, and now it is the time for them to accept the risk of responding to these changed conditions, as they said they would in 1947. Green water is one example of something Reserve did not take into account when they originally applied for their permit.

MR. STEIN: All right. Again, I have heard this from Mr. Merritt and now from you about the meaning of our law. The difficulty that I find with this is you can say our law means something different than we think it means, than the lawyers for the Department of Justice think it means, than the lawyers for the States who testified before the Congress, than the people who drafted the law in the House and the Senate of the United States think it means, and I guess that is your privilege, but that doesn't change what the law says. And again I have to go back when we get a situation and deal with a quote from Justice Holmes. I think from your paper you have demonstrated that you are a bright young man. He said, "Any bright young man can tell you what the law ought to be, but it takes a scholar to say what the law is."

The problem is we have to administer the law as it is, not the way it ought to be. I may agree with you that your views of what the law should be are what would be better than what we have, but we just are stuck with the law as it is and that is the way our system works.

As I pointed out, our jurisdiction here is confined to pollution in one State-- to abatement of pollution in one State, which is caused by a discharge in one State endangering health or welfare of persons in another State.

I have one point that I would like to make, and I think this is a significant one in your statement, and maybe Minnesota or Reserve when they come up can comment I think this is the statement of Mr. Furness at the first conference that the tailings are inert, inorganic, insoluble in Lake Superior and biologically inactive is the basis, I think, of the scope which we have been operating on. I think that this has been the basis of conference judgments and determinations, also the basis of our laboratory and Dr. Mount's studies and other studies to judge whether these materials are in fact inert, inorganic, insoluble and biologically inactive. And I think with that as the scope of the case, we have moved forward.

However, if these statements are correct--and I would like some comment on it when the appropriate parties come up--that "it dumps substantial quantities of calcium chloride into Lake Superior," and that "they dumped sulphuric acid into the lake, and that they have dumped many times the amount of chemicals"--this is vague; I would like that to be more specific--"than a sewage treatment plant dumps," this is not dealing with the characteristics, as far as I can see, of taconite tailings. If this is the case, I think we had better know about that and decide what we are going to do about it. I would like to thank you, Mr. Ulrich, for bringing this up. Until I read this I didn't think that we had a question of other hazardous materials and materials other than the taconite tailings, and that it was appropriate for us to make a determination what the effects of these were.

Are there any other comments or questions?

MR. PURDY: A comment.

MR. STEIN: Yes.

MR. PURDY: Mr. Stein, I, for one, would not like the record to stand that as conferees we are waiting for a dead body to be floating in Wisconsin waters.

(Laughter.)

As a conferee, though, I am waiting for some good solid information to show that an injury to the health and welfare of a person in a State other than in which the discharge is originating is occurring. This matter of bacterial growth, and so forth, as I remember that report, indicated that under certain laboratory conditions that the tailings would accelerate bacterial growth and it could do this. And I could walk across the street and get hit with a car.

But what I would like to see brought into the record here is in fact are the tailings accelerating bacterial growth in the lake. I am not talking about a laboratory condition. I want to know what is taking place in the lake. As soon as we have that information, I, for one, as a conferee am ready to act.

MR. STEIN: All right. By the way, Mr. Purdy--and thank you very much for that, because, as you know, that was my second point that I took up on the interpretation of what our law is--I think you did say "health and welfare." Really, you will accept "health or welfare"?

MR. PURDY: "Health or welfare."

MR. STEIN: Let me go down the laundry list of what "health or welfare" are for purposes here so you know what we are dealing with and we don't have any confusion. As I say, anyone can agree or disagree with what you think the law is, but I don't think there is any disagreement among the conferees of what we think the law is or the scope of the Federal statutes.

Among other legitimate uses, "health or welfare" means this:

1) Of course, affecting public health.
2) Public water supplies.
3) Propagation of fish, wildlife, aquatic life.
4) Recreation. Not necessarily in order.
5) Industrial uses.
6) Agricultural uses.

If a discharge endangers any one of these uses it is subject to abatement here. In a case such as we have, if we are dealing with a discharge in Minnesota, we have to show that it is endangering these uses that I talked about which constitute health or welfare in any one of them, in either Wisconsin or Michigan if the discharge is in Minnesota, and if it is in any of the other States that it is a contributor to the two States not mentioned.

This is the scope of the statute, the Federal statute, that we are operating under now, and I don't think there is any disagreement among the conferees or anyone else who has reviewed this matter back in our home offices of what the jurisdiction is.

MR. ULRICH: Mr. Stein, I would like to respond to a couple of these points.

We did not intend to dispute your interpretation of jurisdiction at any length. We merely wanted to say we may not agree with it. And for that very reason we went on to try to answer the interpretation of jurisdiction which has been adopted by the conferees and which you believe is correct. And you may be right; we are not making a judgment on that.

The first point on page 7 is that we think there is evidence, there is scientific evidence, upon which you can base a legal or a policy judgment and find interstate jurisdiction.

As far as my testifying to the scientific data, I can do little more than list conclusions. There are several people here--I don't think I should mention them; you know as well as I do, the water quality people--who could easily testify to the meaning of the National Water Quality Lab's report. And I was told last night something that is very obvious, that if there is a concentration occurring in Minnesota waters, it is fairly likely that it will occur in Wisconsin waters because of the current around the western end of the lake. This may not be satisfactory evidence, since it takes a certain train of events.

But the two suggested courses of action flow from our belief that this conference has not been able to really come up with any solution to the Reserve problem and this is now the third session. We thought we would offer our opinion on something that might be done.

MR. STEIN: Really this is the second session. We just set off that second session and had a six-month interval until we could get the report. We are still in the second session.

MR. BADALICH: Mr. Chairman.

MR. STEIN: Yes.

MR. BADALICH: Mr. Stein, I believe the Minnesota presentation during this conference will tend to answer the question that Mr. Purdy posed to you this morning.

MR. STEIN: All right. Thank you. I know this is what we are looking for here, and I think we have anticipated that.

I do think that we had a very excellent statement from Mr. Ulrich. Of course, don't get the notion that because someone has an idea of where we go from here that other people haven't thought that too. And I think you have spotlighted some of the areas that we have to get into.

Thank you very much.

(Applause.)

Mr. Merritt, do you want to come again or are you set?

MR. MERRITT: We would like to wait until later on in the session.

MR. STEIN: Well, any citizen who doesn't speak now is going to have to wait until way at the end. This is the opportunity. We just can't turn speakers on and off like faucets here.

MR. MERRITT: It would be nice if we had the agenda ahead of time. We do have Dr. Carson. I would like to ask for time later on.

MR. STEIN: I am always happy when you use the word "nice," Mr. Merritt. Then I know we're in shape.

(Laughter.)

Are you ready?

MR. SHINER: I have got to put the slides in and find out if they are in order.

MR. STEIN: We will have a 10-minute recess.

(RECESS)

MR. STEIN: Let's reconvene.

Mr. Shiner, can you get started, please?

MR. SHINER: Yes, sir.

JOHN T. SHINER

CHAIRMAN, GREAT LAKES REGION

STUDENT COUNCIL ON POLLUTION AND ENVIRONMENT

MINNEAPOLIS, MINNESOTA

MR. SHINER: Students Council on Pollution and Environment is a students' liaison group with the Department of the Interior, with emphasis placed on the Federal Water Quality Administration. As the Great Lakes Region SCOPE representative here today, first let me offer channels open to SCOPE to all of you to assist you in communicating with the Federal Government.

Reserve Mining Company is still the biggest newsmaker at this conference. Justification for this dubious honor comes easily. They have fought citizens' concerns at the highest level for several years now. They are half owned by one of the most notorious polluters in the East, Republic Steel Corporation.

SCOPE's considered position requests that the Army Corps of Engineers follow the recommendations of the Department of the Interior to invalidate the Army Corps of Engineers permit. We all should note, and Mr. Ryder should transmit to the Army Corps of Engineers, that not to do so on the Corps of Engineers part will indicate to the public that the Department of the Interior is more concerned about the environment and the Army Corps of Engineers is more concerned about industry.

On the screen right now is one slide* taken from an airplane, obviously, of Reserve Mining Company's green water.

Could we see the second slide.

If you look closely and you have a chance to see it closely you will see a gray area, which is the delta. If you look to the right in the water you will see what is called"green water." The area towards the top of the screen with blue is sparkling blue Lake Superior water.

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*Slides were not reproduced.

Could I have the next slide.

Here is another shot of basically the same thing, showing the green water effect.

This conference is concerned, however, about Lake Superior and Reserve is obviously not the only polluter of this sparkling blue water. SCOPE, with help from Save Lake Superior Association and from Youth for Environmental Action in Minneapolis, has recorded on film some of the major polluters from the St. Louis River.

Could we have the next slide.

I hope that all of you can see the two shades of green that we have here. The lighter green is from the shoreline, the shore sediment. The darker green is water coming down the St. Louis River through the Superior Bay and into Lake Superior. The photographer assured me that we would not be able to show a second order of green water with the blue water which occurs somewhere between two or three thousand yards out into the lake.

Could I have the next slide, please.

Here is a mixing zone of the two colors of water.

The next slide.

The two previous slides were from the Duluth entry, looking at it from the Lake Superior side. This is Conwed, a pulp processor in Cloquet, Minnesota. They have a large plant which uses the St. Louis River to carry away their wastewater, which you see here.

May I see the next slide?

And the next.

Keep your eye on the river at this point.

And the next slide.

And the next.

In this slide please notice the brown water mixing with the far less polluted water of the St. Louis River.

Could I have the next slide.

Here is the Northwest Paper plant, the second pulp processor in Cloquet.

Could I have the next slide?

The same company, but a view from the back. The white water you see is suds formed by a dam just to the right of the slide.

And the next slide.

In this slide you can't miss the air pollution. This company's air effluent can be smelled on Highway 61 at least 5 miles away. I have been to Duluth about four times and I haven't missed it yet. Also notice some holding ponds in the lower left.

And the next slide.

The holding ponds are making their contribution of pulp plant wastewater in the upper left portion of the slide. From this view--

Could I see the next slide.

From this view you can see not only the suds from the holding pond, but also the brown water. It is not too awfully clear, I am sorry, but you do see the suds coming out.

And the next slide.

Here are some more holding ponds. Please notice the brown water that will flow into the St. Louis River. That is the body of water just to the lower right there.

And the next slide.

As we travel down the river, next we come to Universal Atlas Cement and U. S. Steel. This is the cement company plant.

And the next slide is the sign for the Duluth

Works, U. S. Steel.

And the next slide.

Both companies make contributions to the St. Louis River and the air we breathe. I hope that most of you can see the large area of red water. Water is blue, basically, if it were clean, but this is red water. At the bottom of the slide there is a corner of a housing residential area there to give you some idea of the scale of the volume of red water affected there.

And the next slide.

The black and yellow colors you see are oxides of sulphur and nitrogen. The black smoke is fly ash. Unfortunately, we didn't catch U. S. Steel with its blast furnaces on.

The next slide.

This is the Minnesota Power and Light generating plant out in Superior Bay. Most residents are aware of its air pollution.

In the next slide.

And then the next slide.

And also the next slide.

But few people realize that they dump their fly ash directly into Superior Bay, from the next slide.

Notice the fly ash mixing with Superior Bay water. Notice that extension of their delta toward the bottom of the screen. This section is from--

And the next slide.

This stream of pollution from the plant, if you are fairly close and you look closely, you can see some steam rising from this small stream. You will have to use your imagination to be able to smell this pollution.

The next slide.

Superwood Corporation--from the next slide--is a large manufacturer--from the next slide--of hardboard products.

And the next slide.

They take these logs and make car door panels, TV setback covers, chair seats, and, incidentally, a little money.

And the next slide.

Unfortunately, there are unseeable byproducts, such as air pollution and water pollution.

Next slide.

This slide includes the Superwood plant, and near the top of the screen you see Superwood's answer to a low pollution profile. If you look closely at that jagged piece of ground towards the top of the slide and you look at the end of it, unfortunately it isn't too effective from my distance, but if you look closely you will see the brown water coming from the end of that jagged piece of land. The land is owned by Superwood, and they brought an 8-inch pipe the length of it to an underwater outlet of their effluent.

The next slide.

Superwood's effluent has a 5-day BOD 4,660 milligrams per liter. The WPC 15 reads on the order of, if I am not mistaken, somewhere less than 50. Suspended solids in this effluent is 1,030 milligrams per liter. For Lake Superior the standard, I believe, is 60 milligrams per liter. The pH of this water is 4.4 It is not the kind of thing you could swim in. Phosphorus is 2.7 milligrams per liter, nitrogen--total nitrogen, total phosphorus--total nitrogen is 21.5 milligrams per liter.

And the next shot.

Taking a closer look at Superwood, from the next shot, here is a closeup shot. Hopefully all of you can see the little brown pieces of organic material, slimy organic material, growing in the effluent from

Superwood.

And the next slide.

The previous slide was taken from the lower left-hand corner, and if you notice the density or the color of the water in that shot, notice that it is far thicker just behind the cement lock there.

And the next shot.

This is an I-R shot. This kind of I-R film does accept visible light, but please notice that the lighter green indicates two things, both an increased temperature and the presence of organic material, dead organic material in this case.

And the next shot.

This is just an illustration of how it just doesn't go away. This was taken to the right of the previous shot and it still is of enough volume not to mix entirely.

The next shot.

Superior Fibre Products is another pulp manufacturer whose processing water is dumped into Superior Bay.

May we see the next shot.

At the lower--at the far left of this shot is their effluent coming from some holding basins.

From the next shot you can see it clearer. Obviously the holding basin isn't nearly enough.

While we were getting these pictures we noticed a few other problems, such as this next slide.

As we were flying over in the entire 2-hour air flight over the bay area, someone was burning something in great, great quantities with huge amounts of black smoke.

The next slide.

This is a steel recycler. We are all for recycling, but from the next shot we would hope that they would find a better way to separate the steel from the insulation or whatever else it might have been.

The next shot.

This should be of great interest to those citizens of Duluth, for this is Duluth city sewage.

And the next shot will show its beautiful green color.

The next one.

Here is an air pollution problem again, which I take this opportunity to promote or to show to most of you. This is owned, incidentally, by Arrowhead Blacktop

Company, who have their offices on the second floor of the Superwood offices.

And the next.

In all fairness, I would like to point out that the State of Minnesota has all of these polluters or all of their polluters, at any rate, under stipulation except Superwood, who is on their way to court. Special notice also should be made of U. S. Steel, who have until 1973, everyone else's completion date for being in compliance of WPC 15, to present a report of what they will do. It should be very interesting to see if the Federal Water Quality Administration will accept this stipulation when their time comes.

Thank you very much.

(Applause.)

MR. STEIN: Thank you.

May we have your full name, please?

MR. SHINER: Mr. John T. Shiner, 305-1/2 West Lake Street, Minneapolis, Minnesota, 55408.

MR. STEIN: Are there any comments or questions?

If not, thank you very--

MR. BADALICH: Mr. Chairman.

MR. STEIN: Yes.

MR. BADALICH: I would like to compliment Mr. Shiner on the fine and excellent photography, but I think it certainly indicates the necessity and the reason why the Minnesota Legislature created the Minnesota Pollution Control Agency and the fact that we do have the tools now, the effluent requirements, the emission requirements, water quality regulations, air quality regulations, to cope with these particular discharges. And I think from our report this morning and from our previous reports here to the conference, it certainly indicates that we do have all of the dischargers either under a stipulation, under a compliance schedule, or we are proceeding in the courts.

MR. STEIN: Right.

MR. BADALICH: So I think he has done a wonderful job in bringing forth the polluters in the area, and I am sure corrective measures will be taken within the specified time.

MR. STEIN: Right.

Mr. Badalich, may I ask you while Mr. Shiner is there, as far as those pictures showed, there were no surprises to you, were there? You knew about all these sources, didn't you?

MR. BADALICH: I think we had a very good representative picture of this before Mr. Shiner's pictures.

MR. STEIN: Right.

MR. BADALICH: So I think it was pretty well taken.

MR. STEIN: Right. Thank you.

MR. SHINER: Mr. Stein.

MR. STEIN: Yes.

MR. SHINER: May I reply to Mr. Badalich's comments?

MR. STEIN: Yes.

MR. SHINER: I would like to say that in attempts to make this presentation far more factual and far more accurate relative to the governmental situations, the conditions of the stipulations, et cetera, I was unable to get particulars from the Minnesota Pollution Agency on many of these things, things that I would consider very important to present for this kind of presentation.

I would also like to say that I understand and I have a great desire in seeing the Minnesota Pollution Control Agency supported very well in the coming legislature, because on several of the specifics where I showed people slides and said, "Now, what is this, and what do you know about it, and what is the legal situation here as far as getting it straightened out?" the Pollution Control Agency was unable, and it is certainly not from not wanting to be able to, but was unable, because of staffing, to give me a proper answer.

And thus I would like to say that while the Pollution Control Agency is doing what they can, they certainly need more resources to do the job that is really needed.

Thank you very much.

MR. BADALICH: Thank you, Mr. Shiner, for your support. And if you are speaking about the stipulations, they are of record, they are of public record, and they are certainly available for your inspection any time you desire in the office of the agency.

MR. SHINER: I will be sure to talk to you later for particulars.

MR. BADALICH: Fine, sir.

MR. SHINER: Thank you.

MR. STEIN: I would like to say this about all three States concerned here. As far as I know, and I say this on the basis of real long experience, they all have an open file system. I have not known any one of these States not to be able to produce and have available, certainly to us or to the public, any information that is requested in a reasonable manner.

I would like to make one request to the people who are coming up to make presentations. We are a water pollution conference. I am asking you, in the interest of time, while we have very lax rules and liberal rules about presentation of material, try to keep it germane. I know we have other problems and very important problems, such as foreign wars, atomic bombs, air pollution, but we are really here to talk about water pollution.

As far as I know, this concludes the public statements, and I think before lunch we may be able to get on with that technical report.

Mr. Mayo.

FRANCIS T. MAYO
REGIONAL DIRECTOR, GREAT LAKES REGION
FEDERAL WATER QUALITY ADMINISTRATION
U. S. DEPARTMENT OF THE INTERIOR
CHICAGO, ILLINOIS

MR. MAYO: Mr. Chairman, there has been placed before each of the conferees a copy of the Water Quality Criteria for Lake Superior report prepared by the Lake Superior Water Quality Technical Committee. You will recall at the session earlier this year the committee presented to the conferees an earlier version of the report that was not satisfactory to the conferees from the standpoint of their desire to receive from the committee certain specific recommendations for changes in existing water quality standards adopted by the States and approved by the Federal Government for Lake Superior.

The report that has been presented will be talked to by one of the State members of the committee, Mr. Lloyd Lueschow, of the Wisconsin Department of Natural Resources.

MR. STEIN: While Mr. Lueschow is coming up, I would like to read a telegram I just received, addressed to me:

"Again I urge the most vigorous enforcement of highest pollution control standards for Lake Superior, including specifically action against degradation caused by tailings from Reserve Mining Company plant at Silver Bay. Copper Country Chamber of Commerce has expressed to me similar firm stand."

Signed Philip A. Hart, United States Senator.

(Applause.)

Yes, would you continue, please.

LLOYD A. LUESCHOW
WISCONSIN DEPARTMENT OF NATURAL RESOURCES
MADISON, WISCONSIN

MR. LUESCHOW: Mr. Mayo, Mr. Stein, conferees.

I am Lloyd Lueschow, Wisconsin Department of Natural Resources, and at this meeting I represent the Lake Superior Enforcement Conference Technical Committee.

The Technical Committee is composed of technical representatives from Wisconsin, Minnesota, Michigan, and the Federal Water Quality Administration.

There was Canadian participation in this report, and the report is what I would consider a consensus of opinion of the technical representatives.

On October 1, 1969, the Lake Superior Enforcement conferees, in an executive session at Duluth, Minnesota, after review of conference testimony of May 1969, reached a series of conclusions and recommendations designed to protect the quality of Lake Superior water for future generations.

Recommendation Number One was specifically designed to develop water quality criteria for the lake water. The recommendation called for a technical committee to evaluate the parameter levels that pose an environmental hazard to the Lake Superior ecosystem.

The first committee report was presented at a reconvened session of the conference held on April 29 and 30, 1970. In essence this report called for the establishment of water quality "guidelines." The guideline concept had some basic technical and administrative advantages, but the disadvantage of not providing certain legal enforcement opportunity. The report of April 1970 was rejected by the conferees and the problem referred back to the technical committee for criteria recommendations that could be incorporated into the State water quality standards. The Lake Superior Water Quality Technical Committee reconvened on May 28, 1970, in Minneapolis, Minnesota, for the purpose of providing water quality standards recommendations.

Those recommendations are tabulated and hereby provided to the conferees in the attached report entitled, "Water Quality Criteria for Lake Superior; August 1970."

The committee elected to consider a series of parameters, and for purposes of introduction I will go through those rapidly.

The dissolved oxygen: The minimum 90 percent was regarded to be 10.0 milligrams per liter, the maximum level that should be recorded was 9.0 milligrams per liter, and the justification for these levels was on the basis of nondegradation.

The total dissolved solids: The 90 percent level was considered to be 65.0 milligrams per liter, again based on nondegradation.

Total coliform bacteria were considered to be 10 per 100 ml for a 90 percent value and a maximum value of 1,000 per 100 ml. The 90 percent value is based on water use and the maximum--excuse me--the 90 percent value is based on nondegradation and the maximum value based on water use.

Fecal coliform bacteria were considered to be 10 per 100 ml and maximum value of 200 per 100 ml. The 90 percent value again nondegradation and the maximum value based on water use considerations.

Phenols: The maximum value considered was 0.001 milligrams per liter, based on water use considerations.

Iron: The 90 percent value was 0.03 milligrams per liter and the maximum value considered was 0.1 milligrams per liter, both on nondegradation.

Cadmium: The maximum value considered was 0.0005 milligrams per liter, or 5/10ths parts per billion, based on a nondegradation justification.

Chromium: 90 percent value of 0.02 milligrams per liter, the maximum value 0.05, the 90 percent value based on nondegradation and the maximum based on the water use consideration.

Copper was 0.008 milligrams per liter for 90 percent value and 0.012 milligrams per liter for a maximum value, based on water use considerations.

Lead: 0.03 milligrams per liter 90 percent value, 0.05 for maximum value, based on water use considerations.

Nickel: 0.015 and 0.03, based on nondegradation.

Cyanide: 0.002 milligrams per liter and 0.004, the 90 percent value based on nondegradation and the maximum value based on a water use concept.

Taste (Chloroform Extracts): 0.03, 0.05, based on nondegradation.

pH should be in the range of 6.8 to 8.5 units, based on nondegradation considerations.

Turbidity: 0.5 JTU was the 90 percent value and 5.0 JTU for the maximum value, based on nondegradation considerations.

Ammonia nitrogen: 0.05 milligrams per liter for the 90 percent value, 0.1 milligrams per liter for the maximum value, based on nondegradation.

Excuse me, I left one item out here. There was a general recommendation for nonpersistent wastes and/or those that have noncumulative effects discharged directly to Lake Superior, and for other individual chemicals the 90 percent value is 1/20th of the 96-hour immediate toxicity level and the maximum value is 1/10th of the 96-hour median toxicity value.

For persistent complex wastes and/or those that have cumulative effects and other individual materials the 90 percent value is 1/100th of the 96-hour median toxicity value and the maximum value is 1/20th of the 96-hour median toxicity value.

Decision on the determination of persistent and nonpersistent wastes shall be that of the regulatory agencies. Limitations on certain persistent materials, such as chlorinated hydrocarbons, may be, by necessity, much more stringent than listed 96-hour median toxicity levels.

Some of the parameters evaluated could not be recommended as criteria due to insufficient available data or to analytical unreliability. Where the parameter could not be recommended for criteria and standards, it was evaluated in light of the best information available and levels are hereby recommended as enforcement guidelines.

I will not identify the levels here. I will only identify the parameters.

The color--

MR. STEIN: Before you go on that, I wish you would clarify something for me. Do these 90 percent values or maximum values that you give for color have any effect on this green water? Will they meet this or not or will they be out?

MR. LUESCHOW: I think we are going to need some additional data on that, and I think that was the reason it was selected for a guideline.

MR. STEIN: In other words, you don't know whether green water meets the turbidity and absorption units?

MR. LUESCHOW: There is one basic reason why I don't know, because we are calling for turbidity-free analysis here, which involves spinning the sample and removing any turbidity, and color should, under this consideration, refer to true color. We would have to have additional data on green water to make a recommendation for a standard there.

MR. STEIN: I am afraid I am not getting my question across.

MR. LUESCHOW: You did, sir.

MR. STEIN: The point is, does green water meet this requirement or not? If we don't know, how did you pick these numbers?

In other words, if we get green water and we check green water out, will it violate your guidelines or will it not?

MR. LUESCHOW: I suspect if we spin that green water 20 minutes at 2500 rpm, we should spin that color out of there, and that is the test.

You are quarreling with the test procedure and in a particular situation.

MR. STEIN: No, I am not.

Why couldn't you perform the test?

MR. LUESCHOW: You can perform the test. I am only saying we don't have the data with spun-out green water to know if it exceeds this value or not.

MR. STEIN: How long would it take to do this?

MR. LUESCHOW: I don't know, sir. A short time.

MR. STEIN: O.K. Here is what I am getting at. If one of the major problems we have had in this conference, it is something that has come up again and again, is this discussion of green water and it is going to take a short time to get the answer, I think we should. At least I would propose that the Federal people, at least, make these facilities available and get an answer on that one, because it seems to me I have heard a lot more about green water here in these conferences than I have ever heard about cadmium or chromium, which you have got figures on. I am not saying this in any critical way at all, but I think the issue here is not to just give us the terms that you call parameters because they are easy and they are available in the literature, but we have to zero in on the situations where we feel we have a problem.

And if the green water is going to present a problem, and I find it hard to define just what the problem is with that green water, I think we should run the testing gauntlet and know what we are talking about.

MR. LUESCHOW: Yes, sir, we do, too. And it was recommended as a guideline with the particular wave bands established to do it. But at the time the committee met that data wasn't adequately reviewed or available to make a criteria recommendation.

MR. STEIN: All right. Thank you. Go ahead.

MR. LUESCHOW: The parameter :color, methylene blue active substances, phosphorus, mercury, zinc, hydrogen sulfide, at the bottom water interface, temperature and radioactivity.

The public, the Lake Superior Water Quality Technical Committee, the State and Federal regulatory agencies recognize the uniqueness of Lake Superior. To protect Lake Superior's water quality, with the best interests of the public being the principal consideration, the committee respectfully recommends that:

1) The conferees adopt the recommended water quality criteria for the open waters of Lake Superior as developed by their technical committee.
2) The recommended guidelines serve as an administrative instrument to the State and Federal regulatory agencies in the consideration of wastewater discharges and cultural activities that affect Lake Superior.
3) Appropriate numerical values in place of the recommended guidelines be adopted as criteria after evaluation of additional data. Methylene blue active substances should remain as a guideline.
4) The States of Michigan, Minnesota and Wisconsin adopt these criteria when revising their water quality standards for Lake Superior, in accordance with the Federal Water Quality Act of 1965.

L. A. Lueschow

5) Data collected in accordance with Conference Recommendations 4, which states in part that "The FWQA and the States substantially strengthen water quality surveillance plans for the Lake Superior Basin ..." be compiled and disseminated by FWQA. These data will be used in revising the recommended guidelines.

MR. STEIN: Thank you very much for the report.

(Which report follows:)

REPORT OF THE LAKE SUPERIOR WATER QUALITY TECHNICAL COMMITTEE

PRESENTED TO THE LAKE SUPERIOR ENFORCEMENT CONFEREES

August 12-13, 1970

Lloyd A. Lueschow
Wisconsin Department of Natural Resources
Madison, Wisconsin

On October 1, 1969 the Lake Superior Enforcement Conferees, in an executive session at Duluth Minnesota, after review of conference testimony of May 1969, reached a series of conclusions and recommendations designed to protect the quality of Lake Superior water for future generations.

Recommendation Number one was specifically designed to develop water quality criteria for the lake water. The recommendation called for a technical committee to evaluate the parameter levels that pose an environmental hazard to the Lake Superior ecosystem.

The first committee report was presented at a reconvened session of the conference held on April 29-30, 1970. In essence this report called for the establishment of water quality "guidelines". The guideline concept had some basic technical and administrative advantages but the disadvantage of not providing certain legal enforcement opportunity. The report of April 1970, was rejected by the Conferees and the problem referred back to the technical committee for criteria recommendations that could be incorporated into the State Standards. The Lake Superior Water Quality Technical Committee reconvened on May 28, 1970 in Minneapolis, Minnesota for the purpose of providing water quality standards recommendations.

Those recommendations are tabulated and hereby provided to the conferees in the attached report entitled "Water Quality Criteria for Lake Superior; August 1970."

TABLE I[1]

Criteria Recommendations for Lake Superior Water Quality

Parameter	90% Value	Maximum Value	Justification
Dissolved Oxygen	10.0 mg/l	9.0 mg/l	Non-degradation
Total Dissolved Solids	65.0 mg/l	---	Non-degradation
Total Coliform Bacteriology	10 per 100 ml	1000 per 100 ml	90% Value-Water Use Maximum Value-Water Use
Fecal Coliform Bacteriology	10 per 100 ml	200 per 100 ml	90% Value-Non-degradation Maximum Value-Water Use
Phenol	---	0.001 mg/l	Water Use
Iron	0.03 mg/l	0.1 mg/l	Non-degradation
Cadmium	---	0.0005 mg/l	Non-degradation
Chromium	0.02 mg/l	0.05	90% Value-Non-degradation Maximum Value-Water Use
Copper	0.008 mg/l	0.012 mg/l	Water Use
Lead	0.03 mg/l	0.05 mg/l	Water Use
Nickel	0.015 mg/l	0.03 mg/l	Non-degradation
Cyanide	0.002 mg/l	0.004 mg/l	90% Value-Non-degradation Maximum Value-Water Use
Taste (Chloroform Extracts)	0.03	0.05 mg/l	Non-degradation

(Table 1 cont.)

Paramater	90% Value	Maximum Value	Justification
pH	Range 6.8 - 8.5 Units		Non-degradation
Turbidity	0.5 JTU	5.0 JTU	90% Value-Non-degradation Maximum Value-Water Use
Ammonia Nitrogen	0.05 mg/l	0.1 mg/l	Non-degradation
General	For non-persistent		Non-degradation

[1] Summary of Tables 1 and 3 - Report of Lake Superior Water Quality Technical Committee of the Lake Superior Enforcement Conference.

Some of the parameters evaluated could not be recommended as criteria due to insufficient available data or to analytical unreliability. Where the parameter could not be recommended for criteria and standards, it was evaluated in light of the best information available and levels are hereby recommended as enforcement guidelines.

TABLE II [1]

Guideline Recommendations for Lake Superior Water Quality

Parameter	90% Value	Maximum Value	Justification
Color Wavelength A 4000-8000 angstroms (10 cm light path)	0.05 Absorbance Units. (Turbidity free)	0.25 Absorbance Units (Turbidity free)	Additional Data Required
Wavelength B 2400-4000 angstroms (10 cm light path)	0.50 Absorbance Units (Turbidity free)	2.50 Absorbance Units Turbidity Removed.	Additional Data Required
MBAS	No Increase Above Naturally Occurring Levels		Further investigation of course warranted
Phosphorus	-----	0.01 mg/l (Total P)	Inconsistencies in available data & methods
Mercury	-----	-----	No data available
Zinc	0.01	0.015	Additional data necessary
Hydrogen Sulfide (Bottom-Water-Interface)	.002	.02	Additional data needed
Temperature	No Increase Above Background		Additional data needed
Radioactivity	No Levels Established		Model Criteria being developed by FWQA, AEC & PHS

[1] Summary of Tables 2 and 3 - Report of Lake Superior Water Quality Technical Commitee of the Lake Superior Enforcement Conference.

The Public, the Lake Superior Water Quality Technical Committee, the State and Federal regulatory agencies recognizes the uniqueness of Lake Superior. To protect Lake Superior's water quality, with the best interests of the public being the principal considerations, the committee respectfully recommends that:

1. The conferees adopt the recommended water quality criteria for the open waters of Lake Superior as developed by their technical committee.

2. The recommended guidelines serve as an administrative instrument to the State and Federal regulatory agencies in the consideration of wastewater discharges and cultural activities that affect Lake Superior.

3. Appropriate numerical values in place of the recommended guidelines be adopted as criteria after evaluation of additional data. MBAS should remain a guideline.

4. The States of Michigan, Minnesota and Wisconsin adopt these criteria when revising their water quality standards for Lake Superior, in accordance with the Federal Water Quality Act of 1965.

5. Data collected in accordance with Conference Recommendations 4, which states in part that "The FWQA and the States substantially strengthen water quality surveillance plans for the Lake Superior Basin . . ." be compiled and disseminated by FWQA. These data will be used in revising the recommended guidelines.

WATER QUALITY CRITERIA
FOR
LAKE SUPERIOR

Prepared by the
Lake Superior Water Quality Technical Committee
of the
Lake Superior Enforcement Conference
August, 1970

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I. INTRODUCTION

On the basis of reports, surveys or studies the Secretary of the Interior on January 16, 1969 called a conference in the matter of pollution of the interstate waters of Lake Superior and its tributary basin (Minnesota-Wisconsin-Michigan) under the provisions of Section 10 of the Water Pollution Control Act as amended.

The conference was held May 13-15, 1969 and an executive session was held September 30-October 1, 1969 at Duluth, Minnesota.

At the executive session the conferees reached a number of conclusions and recommendations after appraising water pollution in the Lake Superior basin. They agreed the water quality in Lake Superior is generally unequalled anywhere in the world and that steps should be taken to protect that quality for future generations.

Recommendation Number 1 concerned itself specifically with the development of appropriate water quality criteria for the lake. That recommendation states:

> "It is recommended that a technical committee to evaluate water quality criteria for Lake Superior be formed of the conferees and such representatives as they may designate, within two weeks of the executive session. The purpose of the committee is to develop particular water quality criteria as guidelines for modification of the Federal-State water quality standards. The provision of the necessary secretarial assistance to the committee will be the responsibility of the Federal conferee. The committee may coordinate its activities with other committees or agencies, or engage consultants, as it determines appropriate. At the next session of the conference, the committee will report to the conferees on recommendations agreed upon for changing or modifying existing water quality criteria to reflect desired quality conditions in Lake Superior."

Representatives to the Lake Superior Water Quality Technical Committee designated by the conferees held meetings in Madison, Wisconsin on December 12, 1969; Chicago, Illinois on January 27-28, 1970; Minneapolis, Minnesota on February 23-24, 1970; and Chicago, Illinois on April 3, 1970.

A first draft of the committee report was presented at a reconvened session of the conference on April 29-30, 1970. The report was referred back to the committee to identify those parameters that could at this time be recommended as criteria. A further meeting of the committee was held in Minneapolis, Minnesota on May 28, 1970. The recommendations developed by the committee at this meeting are contained in this report.

The following committee was designated to represent the conferees:

Dale S. Bryson, Federal Water Quality Administration, (Chairman)

Glenn D. Pratt, Federal Water Quality Administration (Replaced Frank E. Hall)

Carlos M. Fetterolf, Michigan Water Resources Commission

Francis B. Frost, Michigan Water Resources Commission

Lyle H. Smith, Minnesota Pollution Control Agency

Clarence A. Johannes, Minnesota Pollution Control Agency (Alternate John F. McGuire)

Lloyd A. Lueschow, Wisconsin Department of Natural Resources

Jerome R. McKersie, Wisconsin Department of Natural Resources

Representatives of the Canadian National Government and the Province of Ontario were invited to the meetings and participated as observers.

This report of the Lake Superior Water Quality Technical Committee contains recommendations based on information from published material, testimony of experts, unpublished data from ongoing studies, information presented at the Lake Superior Enforcement Conference and from the background and experience of the committee members.

A great deal of technical background information pertinent to the establishment of water quality criteria was discussed by the committee in their deliberations. The committee felt it was not appropriate to summarize in this report the basic philosophy concerning water quality criteria as related to the various water uses as this is available in the National Technical Advisory Committee's publication entitled "Water Quality Criteria" dated April 1, 1968. The reader is referred to pages 29 and 30 in particular for the basic philosophy which prevailed throughout the discussions concerning water quality criteria for fish and other aquatic life.

The committee felt there was insufficient information on some parameters to adequately delineate the existing quality of the open waters of Lake Superior. This lack affected some of the committee's recommendations.

The committee recognized that a distinction must be made between inshore and open lake waters. The intent of the committee was to identify criteria sufficiently sensitive to signal small changes indicative of potential degradation of the existing open water quality in Lake Superior. Inshore waters were defined as areas affected by tributary stream plumes, shore erosion, thermal bars, or bottom sediments resuspended by wave action. It was recognized that inshore waters would not be static but would change with varying climatological conditions. Waters not defined as inshore waters or mixing zones would be considered as open waters and should reflect the general quality of the lake.

II. PRESENT WATER QUALITY STANDARDS

Water quality standards have been adopted for Lake Superior by the Lake Superior States and approved by the Department of the Interior as required under the provisions of the Water Quality Act of 1965. Michigan's standards for temperature were excepted from approval. The States assigned their highest water use categories to Lake Superior, namely, public water supply, whole-body contact recreation and cold water fishery and included non-degradation clauses. Hence, the water quality standards for Lake Superior are the most restrictive adopted by the States of Michigan, Minnesota and Wisconsin and are among the most stringent standards nationally. The criteria adopted were established using the best available information at that time.

Appendix A lists the water quality criteria adopted by the States of Michigan, Minnesota and Wisconsin for the open water of Lake Superior. A copy of the complete States standards is available from the appropriate State agency.

The existing water quality standards for Lake Superior were designed to protect the waters near the shore of the lake. If these waters are fully protected from adverse quality effects, the open waters of Lake Superior, or the general quality of the lake, will not be degraded.

III. WATER QUALITY CRITERIA

Before truly appropriate water quality criteria can be established for a body of water the existing quality must be fully assessed. This assessment permits determination of areas of the lake in which concentrations of certain parameters approach undesirable limits and establishes a baseline quality from which to measure future changes.

The waters of Lake Superior are among the least studied of any of the Great Lakes. Some data have been gathered principally in near-shore areas over the years by miscellaneous governmental agencies and universities. However, comprehensive data on the open lake are not available.

The committee gathered Lake Superior water quality information from the United States and Canada and used these data to assess the existing quality. The committee also gathered as much information as was available on recently completed and ongoing research concerning criteria for waters similar to Lake Superior. FWQA's National Water Quality Laboratory at Duluth, Minnesota furnished the bulk of these data. Discussions with personnel at that laboratory proved invaluable throughout the committee's deliberations.

The Water Quality Act of 1965 provided that after the initial setting of standards periodic review and revision would be required to take into account changing technology and advances in knowledge of water quality requirements. Ultimately, truly appropriate water quality criteria will be developed for specific bodies of waters.

The committee agreed that although the existing water quality standards on Lake Superior were very restrictive, some were not truly appropriate because they were drafted for all high quality waters of the States, not specifically for the open waters of Lake Superior. The committee felt that sufficient water quality data existed to recommend specific numerical criteria for many parameters. Adequate data were not available for all parameters, therefore, certain values were recommended as water quality guidelines pending evaluation of additional data, after which appropriate numerical values will be recommended as criteria. In the interim, the guidelines should serve as an administrative instrument to the State and Federal regulatory agencies in the consideration of wastewater discharges and cultural activities that affect Lake Superior. The States of Michigan, Minnesota and Wisconsin should adopt the recommended criteria when revising their water quality standards for Lake Superior in accordance with the Federal Water Quality Act of 1965.

The FWQA's report, "An Appraisal of Water Pollution in the Lake Superior Basin", as prepared for the use of the conferees at the Lake Superior Enforcement Conference included details of proposed water quality criteria. Appendix C to that report contained the rationale for the proposed criteria. These criteria and rationale were used as a base for the discussion of the various parameters by the committee.

Table 1 presents the water quality criteria for the open waters of Lake Superior as recommended by the technical committee. Table 2 presents the recommended water quality guidelines. The basis for the actions recommended by the committee are presented in Table 3. Appendix B presents the committee's rationale for water quality criteria. The rationale reflects the agreements reached by the committee.

Waters not defined as inshore waters or mixing zones will be considered as open waters and should reflect the general quality of the lake. Mixing zones may be set by the respective State agencies and reviewed by the FWQA. Waters within the mixing zones must meet the conditions as noted in Table 1, Footnote 1, and Table 2, Footnote 2.

TABLE 1

RECOMMENDED WATER QUALITY CRITERIA FOR THE OPEN WATERS OF LAKE SUPERIOR[1]

(Mg/l unless otherwise specified)[2]

Parameter	90% Value[3]	Maximum Value[4]
Dissolved Oxygen	>10.0	9.0
Total Dissolved Solids	65.0	-
Total Coliform Bacteria	10 per 100 ml	1,000 per 100 ml
Fecal Coliform Bacteria	10 per 100 ml	200 per 100 ml
Phenol	-	0.001
Iron	0.03	0.1
Cadmium	-	0.0005
Chromium	0.02	0.05
Copper	0.008	0.012
Lead	0.03	0.05
Nickel	0.015	0.03
Cyanide	0.002	0.004
Taste-Chloroform Extracts	0.03	0.05
pH	Should remain between 6.8 and 8.5 units	
Turbidity	0.5 JTU	5.0 JTU
Ammonia Nitrogen	0.05	0.1

General: For non-persistent wastes and/or those that have noncumulative effects discharged directly to Lake Superior and for other individual chemicals the 90 percent value is 1/20 of the 96-hour TL_m value and the maximum value is 1/10 of the 96-hour TL_m value. For persistent complex wastes and/or those that have cumulative effects and other individual materials the 90 percent value is 1/100 of the 96-hour TL_m value and the maximum value is 1/20 of the 96-hour TL_m value. Decision on the determination of persistent and non-persistent wastes shall be that of the regulatory agencies. Limitations on certain persistent materials, such as chlorinated hydrocarbons, may be, by necessity, much more stringent than listed 96-hour TL_m values.

1. Inshore waters are defined as areas affected by tributary stream plumes, shore erosion, thermal bars, or bottom sediments resuspended by wave action. Waters not defined as inshore waters or mixing zones will be considered as open waters. Mixing zones may be set by the respective State agencies and reviewed by the Federal Water Quality Administration. In these zones other standards may be applicable but in no case can the 96-hour TL_m value be exceeded for organisms that inhabit the area and the area shall be:

   Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;

Table 1 (Continued)

Free from floating debris, oil, scum and other floating materials or other discharges in amounts sufficient to be unsightly or deleterious;
Free from discharged materials that produce color, odor or other conditions in such degree as to create a nuisance;
Free from substances and conditions or combinations thereof in concentrations that produce undesirable aquatic growths.

2. Concentrations of metals are listed on a total ion basis from unfiltered samples.

3. Ninety percent of the values obtained at one location must not exceed this value. (For dissolved oxygen the stated value is a minimum.) Concentrations exceeding these values signal changes of water quality indicative of potential degradation and warrant further investigation.

4. Maximum value not to be exceeded. (For dissolved oxygen the stated value is a minimum).

TABLE 2

RECOMMENDED WATER QUALITY GUIDELINES[1]
FOR THE OPEN WATERS OF LAKE SUPERIOR[2]

(Mg/l unless otherwise specified)[3]

Parameter		90% Value[4]	Maximum Value[5]
Color	Wavelength A 4000-8000 angstroms 10 centimeters light path	0.05 absorbance units (turbidity removed)	0.25 absorbance units (turbidity removed)
	Wavelength B 2400-4000 angstroms 10 centimeters light path	0.50 absorbance units (turbidity removed)	2.50 absorbance units (turbidity removed)
MBAS		No increase above naturally occurring levels.	
Phosphorus		-	0.01
Mercury		-	-
Zinc		0.01	0.015
Hydrogen Sulfide (as total sulfide measured at bottom water interface)		0.002	0.02
Temperature		No increase above natural background levels.	
Radioactivity		Recommendations for proposed radiological criteria will be deferred pending development of model criteria by Federal Water Quality Administration, Atomic Energy Commission and U. S. Public Health Service. When these model criteria are published an appropriate review will be made at that time to determine their suitability for the open waters of Lake Superior.	

1. Recommended as guidelines pending evaluation of additional data. Appropriate values will be recommended as criteria at completion of evaluation except for MBAS, which will remain a guideline.

2. Inshore waters are defined as areas affected by tributary stream plumes, shore erosion, thermal bars, or bottom sediments resuspended by wave action. Waters not defined as inshore waters or mixing zones will be considered as open waters. Mixing zones may be set by the respective State agencies and reviewed by the Federal Water Quality Administration. In these zones other standards may be applicable but in no case can the 96 hour TL_m value be exceeded for oganisms that inhabit the area and the area shall be:

   Free from substances attributable to municipal, industrial or other discharges that will settle to form putrescent or otherwise objectionable sludge deposits;

   Free from floating debris, oil, scum and other floating materials or other discharges in amounts sufficient to be unsightly or deleterious;

Free from discharged materials that produce color, odor or other conditions in such degree as to create a nuisance;
Free from substances and conditions or combinations thereof in concentrations that produce undesirable aquatic growths.

3. Concentrations of metals are listed on a total ion basis from unfiltered samples.

4. Ninety percent of the values obtained at one location must not exceed this value. (For dissolved oxygen the stated value is a minimum.) Concentrations exceeding these values signal changes of water quality indicative of potential degradation and warrant further investigation.

5. Maximum value not to be exceeded. (For dissolved oxygen the stated value is a minimum.)

TABLE 3

BASIS FOR RECOMMENDED ACTION ON WATER QUALITY CRITERIA FOR THE OPEN WATERS OF LAKE SUPERIOR[1]

Parameter	Recommended Action Adopt As:	Justification
Dissolved Oxygen	Criteria	Non-degradation
Total Dissolved Solids	Criteria	Non-degradation
Total Coliform Bacteria	Criteria	90% value-non-degradation Maximum value-water use-total body contact.
Fecal Coliform Bacteria	Criteria	90% value-non-degradation Maximum value-water use-total body contact.
Phenol	Criteria	Water use - drinking water
Iron	Criteria	Non-degradation
Cadmium	Criteria	Water use-biological effect
Chromium	Criteria	90% value-non-degradation Maximum value-water use-drinking water
Copper	Criteria	Water use - biological effect
Lead	Criteria	90% value-water use-biological effect Maximum value-water use-drinking water
ickel	Criteria	Non-degradation
Cyanide	Criteria	90% value-non-degradation Maximum value-water use-biological effect
Taste	Criteria	Water use - biological effect
pH	Criteria	Non-degradation
Turbidity	Criteria	90% value-non-degradation Maximum value-water use-drinking water
Ammonia Nitrogen	Criteria	Non-degradation
General	Criteria	Water use - biological effect
Color	Guideline	Values adopted pending collection of additional data utilizing extended wavelength technique
MBAS	Guideline	Increases in MBAS concentration signal changes of water quality which may be indicative of potential degradation and warrant further investigation
Phosphorus	Guideline	Appears to be inconsistency in data now available and hence value is adopted as a guideline. Every effort should be made to reduce phosphorus input to the Lake
Mercury	Guideline	Value will be established after reviewing available data.

TABLE 3 (Continued)

BASIS FOR RECOMMENDED ACTION ON WATER QUALITY CRITERIA FOR THE OPEN WATERS OF LAKE SUPERIOR[1]

Parameter	Recommended Action Adopt As:	Justification
Zinc	Guideline	Existing levels of zinc in the St. Mary's River are greater than those proposed and are cause for concern. Every effort should be made to eliminate sources of zinc. Additional data is needed.
Hydrogen sulfide (as total sulfide measured at bottom water interface)	Guideline	Additional data is needed.
Temperature	Guideline	Appropriate numerical values for temperature will be established pending evaluation of additional data.
Radioactivity	Guideline	Recommendations for proposed radiological criteria will be deferred pending development of model criteria by FWQA, Atomic Energy Commission and U. S. Public Health Service. When these model criteria are published on appropriate review will be made at that time to determine their suitability for the open waters of Lake Superior.

1. Parameters adopted as guidelines will be recommended as criteria after evaluation of additional data except MBAS, which will remain a guideline.

IV. RECOMMENDATIONS

The public, this committee, and the State and Federal regulatory agencies recognize the uniqueness of Lake Superior. To protect Lake Superior's water quality, with the best interests of the public being the principal consideration, the committee respectfully recommends that:

1. The conferees adopt the recommended water quality criteria for the open waters of Lake Superior as developed by their technical committee.

2. The recommended guidelines serve as an administrative instrument to the State and Federal regulatory agencies in the consideration of wastewater discharges and cultural activities that affect Lake Superior.

3. Appropriate numerical values be adopted as criteria in place of the recommended guidelines after evaluation of additional data. MBAS should remain a guideline.

4. The States of Michigan, Minnesota and Wisconsin adopt these criteria when revising their water quality standards for Lake Superior, in accordance with the Federal Water Quality Act of 1965.

5. Data collected in accordance with Conference Recommendation 4, which states in part that "The FWQA and the States substantially strengthen water quality surveillance plans for the Lake Superior Basin . . ." be compiled and disseminated by FWQA. These data will be used in revising the recommended guidelines.

Prepared by:

Lake Superior Water Quality Technical Committee
Dale S. Bryson, Chairman
August, 1970

APPENDIX A

LAKE SUPERIOR OPEN WATERS
WATER QUALITY CRITERIA AND DESIGNATED USES
MICHIGAN, MINNESOTA, WISCONSIN

STATE	DESIGNATED USES	COLIFORM GROUP	DISSOLVED OXYGEN	SUSPENDED, COLLOIDAL AND SETTLEABLE MATERIALS	FLOATING MATERIAL, RESIDUES, DEBRIS AND MATERIAL OF UNNATURAL ORIGIN	TOXIC AND DELETERIOUS SUBSTANCES
MICHIGAN	Domestic Water Supply Industrial Water Supply Recreation: – Whole Body Contact – Partial Body Contact Fish, Wildlife and Other Aquatic Life: – Intolerant Fish Cold Water Species – Intolerant Fish Warm Water Species Agricultural Commercial	The average of any series of 10 consecutive samples shall not exceed 1000 organisms per 100 ml nor shall 20% of samples exceed 5000/100 ml Fecal coliforms for the samples ≯100/100 ml	Cold Water Intolerant Species ≮6 mg/l at any time Warm Water Intolerant Species Avg. Daily Value ≮5 mg/l Any Single Value ≮4 mg/l	No objectionable unnatural turbidity, color, or deposits in quantities sufficient to interfere with designated use	No evidence of such material except of natural origin No visible film of oil or globules of grease	Conform to current USPHS Drinking Water Standards, except: Cyanide: ≯0.2 mg/l Chromium: ≯0.05 mg/l Phenols: Mo. Avg. ≯0.002 mg/l Single Value ≯0.005 mg/l Not to exceed 1/10 of the 96-hour TL_m obtained from continuous flow bioassays where the dilution water and toxicant are continuously renewed except that other application factors may be used in specific cases when justified on the basis of available evidence and approved by the appropriate agency
MINNESOTA	Domestic Consumption (IB) Fisheries and Recreation (2A) Industrial Consumption (3A)	≯50 MPN/100 ml	Oct-May ≮7.0 mg/l Jun-Sep ≮5.0 mg/l	Turbidity ≯5.0 units No discharge from unnatural sources so as to cause any nuisance conditions	Oil ≯ Trace No discharge from unnatural sources so as to cause any nuisance conditions	[≯ - mg/l] Arsenic 0.01 Barium 1.0 Cadmium 0.01 CCE 0.2 Chromium Trace Copper Trace Cyanide Trace Fluorides 1.5 Lead 0.05 Manganese 0.05 Nitrates 45.0 Selenium 0.01 Silver 0.05 Zinc 5.0
WISCONSIN	Public Water Supply Industrial and Cooling Water Commercial Shipping Recreation: – Whole Body Contact Beach areas Fish and Aquatic Life Trout Waste Assimilation	Arith. Avg. ≯1000/100 ml Max. ≯2500/100 ml during recreation season	≮80% Saturation nor ≮5 mg/l at any time ≯1 mg/l change	Substances that will cause objectionable deposits in the bed or on the shore of a body of water shall not be present in such amounts as to create a nuisance	Floating or submerged debris, oil, scum or other material shall not be present in such amounts as to create a nuisance	Substances in concentrations or combinations which are toxic or harmful to humans shall not be present in amounts found to be of public health significance, nor shall substances be present in amounts, which by bioassay and other appropriate tests, indicate acute or chronic levels harmful to animal, plant or aquatic life

> Greater Than ≯ Not Greater Than
< Less Than ≮ Not Less Than

Where designated uses have different criteria the most stringent criteria are listed.

TOTAL DISSOLVED SOLIDS	NUTRIENTS	TASTE AND ODOR PRODUCING SUBSTANCES	TEMPERATURE	pH	RADIOACTIVE MATERIALS
Total Dissolved Solids: ≯ 200 mg/1 **Chlorides:** Mo. Avg. ≯ 50 mg/1 **(MICHIGAN)**	Nutrients originating from industrial, Municipal or domestic animal sources shall be limited to the extent necessary to prevent adverse effects on water treatment processes or the stimulation of growth of algae, weeds and slimes which are or may become injurious to the designated use	Concentrations of substances of unnatural origin shall be less than those which are or may become injurious to the designated use Phenols: Mo. Avg. ≯ 0.002 mg/1 Max. Concentration for a Single Value ≯ 0.005 mg/1	Excepted from Approval	Range of 6.5 - 8.8 ≯ 0.5 unit change within range	≯ 1000 pc/l of gross beta activity in absence of Sr-90 and alpha emitters If this limit is exceeded the specific radionuclides present must be identified by complete analysis in order to establish the fact that the concentration of nuclides will not produce exposure above recommended limits established by the Federal Radiation Council
Total Dissolved Solids: ≯ 500 mg/1 **Chlorides:** ≯ 50 mg/1 **Sulfates:** ≯ 250 mg/1 **Hardness:** ≯ 50 mg/1 **(MINNESOTA)**	No discharge from unnatural sources so as to cause any nuisance conditions	Threshold Odor: Number ≯ 3 Phenols: ≯ 0.001 mg/1	No Material Increase	Within range of 6.5 - 8.5	Gross beta concentration not to exceed 1000 pc/1 in known absence of alpha emitters and Sr-90 **Also:** Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use
Mo. Avg. ≯ 500 mg/1 **Max.** ≯ 750 mg/1 at any time **(WISCONSIN)**	Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to create a nuisance	Materials producing color, odor, taste or unsightliness shall not be present in such amounts as to create a nuisance	84°F Max. Change from natural unpolluted background ≯ 5°F Rate of Change ≯ 2°F/hour	Within range of 6.0 - 9.0 ≯ 0.5 unit change if natural values are above 8.5 or below 6.5	Intake water supply will be such that by appropriate treatment and adequate safeguards it will meet PHS Drinking Water Standards, 1962

APPENDIX B

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DISSOLVED OXYGEN

I. BIOLOGICAL EFFECTS. A continuous supply of oxygen is required for the normal metabolism of fish and most of their food organisms. Oxygen is used also in the respiration of plants and by bacteria. Oxygen enters the water chiefly by diffusion from the air and by the photosynthetic activity of plants. In general a balance is maintained between addition and removal, but because oxygen is not very soluble the water's capacity is small, so that any interference with the influx from the air or production by plants or any sudden increase in utilization (as, for example, in the bacterial oxidation of sewage wastes, etc.) soon lowers it to critical levels.

The oxygen concentration needed for maintenance varies widely with species, and there is evidence that highly desirable fish species in Lake Superior (coregonids, salmonids) require relatively high concentrations. There are indications, also, that several of the important food organisms (gammarids and shrimp) are even less tolerant of oxygen deficiencies. Within any one species the requirement varies with temperature, and especially with life-history stage, the eggs and early fry being more sensitive than the adults to oxygen lack. For such cold-water fish as salmonids a minimum of 6 mg/1 has been recommended for good growth and general well-being of adults and their associated food organisms, and of 7 mg/1 for eggs and fry.

II. SPECIAL CONSIDERATIONS. In addition to providing for growth, activity, reproduction and the like, the oxygen concentration must be high enough to protect against adverse conditions that may be encountered. For example, toxicants that enter through the gills become more toxic as the oxygen concentration is decreased, because the fish must pass more water over the gills to get enough oxygen, and this brings more toxicant against the gill surface. Because the low salt content of Lake Superior water permits such agents as heavy metals to be more toxic than they would be in harder waters, it is especially important that the oxygen concentration be maintained high enough to counteract this hazard.

Little is known about the requirements of the adult stages of the important species of fish and food organisms under the environmental conditions of the bulk of Lake Superior, and even less about those of the more sensitive developmental stages. Further, little seems to be known about the oxygen concentration in various parts of the lake, especially at the bottom where the eggs and early stages of many species must live. Evidently the lake oxygen concentrations that have entered into maintaining the recorded levels at Duluth and Sault Ste. Marie so far have been high enough to maintain the aquatic population, and these should serve as guidelines until we have more information.

It is important to recognize that a reduction in oxygen from existing concentrations would serve as a warning of organic decomposition with subsequent release of poisonous materials such as hydrogen sulfide and ammonia.

III. EXISTING CONDITIONS. The gross range of dissolved oxygen concentrations over the period 1958-1968 was between 9.4 and 14.6 mg/1 at Duluth, and 8.4 and 16.4 mg/1 at Sault Ste. Marie, with means of 12.6 and 12.2 mg/1, respectively.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The dissolved oxygen concentration of the open water of the lake shall not be less than 9 mg/1, at any time or any place in that habitat and 90% of the values should be greater than 10 mg/1. For habitats occupied primarily by warmer water fish (e.g., perch and walleye in the shallower bays) the criteria shall be not less than 5 mg/1 at any time or place in that habitat.

V. REFERENCES.

1. Brinley, F.J. 1944. House Document 266, 78th Congress, 1st Session. Part II, Supplement F, Biological Studies, pp. 1275-1353.
2. Doudoroff, P. and C.E. Warren, 1962. Biological Problems in Water Pollution. Public Health Service; Third Seminar: pp. 145-155. Dissolved Oxygen Requirements of Fishes.
3. Ellis, M.M. 1937. Bulletin U.S. Bureau of Fisheries, Volume 48:365-437. Detection and Measurement of Stream Pollution.
4. Smith, L. L. et al, 1956. Sewage & Industrial Wastes 28:678-690. Aquatic Life Water Quality Criteria: Second Progress Report.
5. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1968.

TURBIDITY AND COLOR

I. BIOLOGICAL EFFECTS. Ecologically, the quality of the light, the intensity and the duration impinging on a given surface area controls the ecosystem through its influence on primary production. Light is the ultimate source of energy, without which life could not exist. Many structural and behavorial characteristics of organisms are directly influenced by light, therefore making it a vital factor as well as a limiting one at both the maximum and minimum levels.

Reduction of light presents a more serious problem in the aquatic environment than in the terrestrial. Light diminishes rapidly even in clear water, and changes in spectral composition and in other respects. Any extraneous material which is introduced to water, whether it be dissolved or suspended, will diminish the light intensity and possibly change the light quality. In short, suspended or dissolved solids absorb light energy, and this absorption will decrease that light energy available for primary production.[1]

Production takes place in the water at a depth to which light penetrates so that in deep water lakes the light-penetrated "surface water" provides the major source of production for the entire depth.[2] Effects of turbidity on desirable fish in Lake Superior would first appear as indirect ones on food supply.

II. CHEMICAL EFFECTS. Increases in turbidity require an increase in the available chlorine necessary for chlorination.[3] Further, an increase in turbidity makes phosphate and radioactivity removal harder to accomplish[4]. Turbidity produces in Lake Superior "colored water" which is not esthetically pleasing.[5]

III. SPECIAL CONSIDERATIONS. Since Lake Superior is deep (average depth about 600 feet) and cold (average temperature $< 42°F$) primary production is already hindered. If light energy is removed because of turbidity or color, further stress would be placed on the lake's primary production. A combination of all these adverse conditions (extreme depth, low temperature, and light absorption) could render the lake practically sterile. Since the lake's depth cannot be controlled, and the cold temperature is required for the natural fish, it is more imperative that turbidity and color be removed from effluents being discharged into the lake.

IV. EXISTING CONDITIONS. Twenty-year averages of turbidity measurements taken daily at the Duluth Water Treatment Plant (Lakewood Pumping Station) show the mean turbidity of Lake Superior at this station to be about 0.3 JTU.

V. RECOMMENDED CRITERIA FOR LAKE SUPERIOR.

Turbidity:	Less than 0.5 JTU (measured by light scattering and dilution of standard solutions for JTU) for 90% of the time. Not to exceed 5.0 JTU as maximum.
Color:	Less than 0.050 absorbance units (10 cm path length, turbidity removed) over wave length range 4000-8000 A, and less than 0.500 absorbance units (10 cm path length, turbidity removed) over the wave length range 2400-4000 A for 90% of the time. Not to exceed five times these values as a maximum. Values adopted pending collection of additional data utilizing extended wavelength technique. Recommended as guideline.

VI. REFERENCES.

1. Odum, E. P. Fundamentals of Ecology, p. 106. W. B. Saunders and Co., Philadelphia, 1959.
2. Clarke, G. L. Elements of Ecology, p. 185, John Wiley and Sons, Inc., New York, 1954.
3. Felsen, D. and Taras, M. J. Journal American Water Works Association, 42, 455 (1950).
4. Eliassen, R. et al. Journal American Water Works Association, 43, 621 (1951).
5. Investigation of the Distribution of Taconite Tailings in Lake Superior, U. S. Department of the Interior, Federal Water Pollution Control Administration, Great Lakes Region, September-October, 1968.

TOTAL DISSOLVED SOLIDS

I. GENERAL CONSIDERATIONS. The quantity of dissolved solids by itself is not especially important in assessing water quality. More important are the kinds of dissolved solids that are present, and in some cases, the ratio of one to another. Only when the total exceeds many times the existing values in the lake, would there be any direct impairment.

Dissolved solids measurements do, however, provide a good index of the aging rate of the lake. Such correlations have been established in Lake Erie, as an example. For this reason, dissolved solids should be kept close to the present level to avoid undesirable aging effects.

II. EXISTING CONDITIONS. No data is available for St. Mary's River, but rarely is 60 mg/1 reached at Duluth.

III. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Ninety percent of the values should not exceed 65 mg/l.

IV. REFERENCES.

1. A Plan for Water Pollution Control - Lake Erie Report. U. S. Department of the Interior, Federal Water Pollution Control Administration. August 1968.

BACTERIA

I. GENERAL CONSIDERATIONS. The presence of bacteria in water was recognized early as an indicator of degraded water quality. The coliform bacterial count has been most widely used as an index of sewage contamination and possible accompanying hazard of human pathogens. Some waters have a high count even though there is little or no sewage contamination as coliform bacteria enter waterways from sources other than man, such as land runoff from agricultural lands.

The cold temperature, extreme water clarity (permitting deep penetration of sunlight) and sparsely populated watershed result in very low counts. The average total coliform value at Duluth is 3.68/100 ml and 7.81/100 ml at the St. Mary's River.

II. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The maximum total coliform count should not exceed 1000/100 ml and 90% of the counts should be less than 10/100 ml at any location. The maximum fecal coliform count should not exceed 200/100 ml and 90% of the counts should be less than 10/100 ml at any location. Analyses performed by the membrane filter technique.

III. REFERENCES.

1. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1968.
2. Sanitary Significance of Fecal Coliforms in the Environment. U.S. Department of the Interior, Federal Water Pollution Control Administration, Publication WP-20-3.
3. The Bacteria, Volume II. Gunsalus and Stanier, Academic Press. 1961.
4. Pollutional Effects of Pulp and Paper Mill Wastes in Puget Sound. U.S. Department of the Interior, Federal Water Pollution Control Administration, March 1967.
5. Proceeding-Eleventh Conference on Great Lakes Research - 1968. International Association for Great Lakes Research.
6. Microbiology for Sanitary Engineers. McKinney, Rose E. McGraw-Hill, 1962, pp. 152.

METHYLENE BLUE ACTIVE SUBSTANCES (MBAS)

10

I. GENERAL CONDITIONS. The methylene blue method is used for quantitatively measuring surfactants, but does not differentiate between the now existing levels of ABS ar LAS occurring in natural waters. Nor does the method differentiate between surfactant and certain natural substances. Therefore, it has been proposed and generally accepte that these anionic substances be reported as methylene blue active substances (MBAS).

The MBAS test provides very sensitive measurement of increases in concentrations of organic compounds in Lake Superior. While the MBAS method does not yield a differentiation of compounds it provides a quantitative measure of change and signals potentia degradation of water quality that warrants investigation.

II. EXISTING CONDITIONS. Available information on MBAS concentrations in Lake Superior indicates a range from 0.01 - 0.05 mg/l.

III. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. There shall be no increase above naturally occurring levels in the MBAS concentration in the open water of Lake Superi Increases in the MBAS concentration signal changes of water quality which may be indicative of potential degradation and warrant further investigation. Recommended as guideline.

IV. REFERENCES.

1. Thatcher, Thomas O., and Joseph F. Santner, 1966. Acute Toxicity of LAS to Various Fish Species. Proceedings 21st Purdue Industrial Waste Conference, Engineering Extension Series No. 121., 50(2): 996-1002.
2. Pickering, Quentin H. 1966. Acute Toxicity of Alkyl Benzene Sulfonate to the Eggs of the Fathead Minnow, *Pimephales promelas.* Air and Water Pollution Journal, 10: 385-391.
3. Pickering, Quentin H., and Thomas O. Thatcher. 1968. The Chronic Toxicity of Linear Alkylate Sulfonates to the Fathead Minnow (*Pimephales promelas* Raf.). Journal Water Pollution Control Federation. In press.
4. Swisher, R.D., J. T. O'Rourke, and H. D. Tomlinson. 1964 Fish Bioassays of Linear Alkylate Sulfonates (LAS) and Intermediate Biodegradation Product Journal of American Oil Chemical Society, 41: 746-752.
5. Marchetti, R. 1965. Critical Review of the Effects of Synthetic Detergents on Aquatic Life. Stud. Rev. Gen. Fish. Coun. Medit., No. 26, 32 pp.
6. Arthur, John W., 1970, Chronic Effects of Linear Alkylate Sulfonat Detergent on *Gammarus pseudolimnaeus*, *Campeloma decisum,* and *Physa integ* Water Research, In press.

PHENOLS AND PHENOLIC COMPOUNDS

I. BIOLOGICAL EFFECTS. Phenols and substituted phenols are toxic to trout and other fish at concentrations of 0.1 to 10 mg/l. Studies of long term effects at lower concentrations have not been made.

Phenolic compounds, particularly the chlorophenols, cause unpleasant odors and flavors in fish from waters containing as little as 0.0001 mg/l. Most phenols are biodegradable, but at concentrations of a few mg/l or less cause nuisance slime and mold growths on rocks, etc.

II. SPECIAL CONSIDERATIONS. Phenols in drinking water are detectable by disagreeable taste and odor at concentrations of 0.001 to 0.01 mg/l, thus the U.S. Public Health Service Drinking Water Standard has been set at 0.001 mg/l. Current waste treatment practices (tertiary treatment) are highly efficient at removal of phenols; however, post-chlorination of the waste increases the proportion of taste and odor causing chlorophenols.

III. EXISTING CONDITIONS. Phenol as such is not routinely measured in Lake Superior. However, data from Duluth and the St. Mary's River indicate that total aromatics (including phenols) average less than 0.001 mg/l.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Based on the potential for causing taste and odor problems in drinking water and in commercial fish, the recommended criteria for phenols in Lake Superior is a maximum concentration of 0.001 mg/l.

V. REFERENCES.

1. Brown, V.M., Jordan, D.H.M., and Tiller, B.A., 1967. The Effect of Temperature on the Toxicity of Phenol to Rainbow Trout in Hard Water. Water Research 1:587-594.
2. Pickering, Q.H., and Henderson, C., 1966. Acute Toxicity of Some Important Petrochemicals to Fish. Journal Water Pollution Control Federation 38 (9): 1419-1429.
3. Ryckman, D.W., Prabhakara Rao, A.V.S., and Buzzel, J.C., Jr. Behavior of Organic Chemicals in the Aquatic Environment: A Literature Critique. Published by the Manufacturers Chemists Association, Washington, D.C., Summer 1966.
4. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1968.

AMMONIA

I. BIOLOGICAL EFFECTS. Ammonia is a normal product of animal metabolism and the major nitrogenous excretion of fish and other freshwater animals. It enters water naturally also by microbial decomposition of decaying plant and animal material, in rain water and, under certain conditions, by the degradation of dissolved nitrites and nitrates. In addition, it enters water as a component of sewage, fertilizers, and numerous industrial wastes. Conversely, it serves as a nutrient for some of the algae. Its concentration is unlikely to remain constant in a normal aquatic environment, but tends to be decreased by conversion to nitrite and nitrate. Because of its many possible sources and fates, the ammonia content of natural unpolluted waters is highly variable, and has been reported to range from 0.0 to about 4.0 mg/1, although usually less than 0.2 mg/1.

The experimental work to date on ammonia toxicity does not provide clear guidelines, partly because the distinction has not always been made between the highly toxic ammonia molecule and the less toxic ammonium ion, and partly because the experiments have been too crude to be related to long-term effects. A concentration of 1.5 mg/1 has been reported as "not harmful to fish", but it has also been reported, however, that 1 mg/1 and even 0.3 mg/1 can affect the oxygen carrying capacity of the blood. Its effects on important fish food organisms of the lake are not known.

II. SPECIAL CONSIDERATION. The higher the pH the greater the proportion of toxic molecular ammonia relative to ammonium ion, the toxicity of ammonium compounds increasing by 200% or more between pH 7.4 and 8.0. Over the period 1958-1968 the pH of Lake Superior water at Duluth has ranged between 7.3 and 8.5, with a mean of 7.72, which is in a critical range for ammonia. Further, because of its low salt concentration Lake Superior water is poorly buffered against changes in pH. For these reasons the standard for ammonia must be extremely conservative to be safe for aquatic life.

III. EXISTING CONDITIONS. Over the period 1959-1966 at Sault Ste. Marie, and 1958-1965 at Duluth, the reported ammonia concentrations ranged between 0.0 and 0.1 mg/1 as ammonia nitrogen, with means of 0.071 and 0.0024 mg/1, respectively.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Since the values so far recorded seem not to have had an adverse effect, since the ammonia concentration is highly labile, and since ammonia is most toxic at high pH ranges, the recommended criteria is a maximum of 0.1 mg/1, expressed as ammonia nitrogen, and 90% of the values should be less than 0.05 mg/1.

V. PERTINENT REFERENCES.

1. Doudoroff, P., and Katz, M., 1950 22:1432-1458. Critical Review of Literature on the Toxicity of Industrial Wastes and their Components to Fish. I. Alkalies, Acids and Inorganic Gases. Sewage and Industrial Wastes.
2. Ellis, M. M. 1937. Bulletin U. S. Bureau of Fisheries. Detection and Measurement of Stream Pollution. Vol. 48: 365-437.
3. Goldstein, L., Forster, R. P. and Fanelli, G. M., Jr. 1964. Gill Blood Flow and Ammonia Excretion in the Marine Teleost, Myoxocephalus scorpius. Comp. Biochem. Physiol. 12: 489-499.
4. Lloyd, R. 1961. Effect of Dissolved Oxygen Concentrations on the Toxicity of Several Poisons to Rainbow Trout. Journal Experimental Biology. 38: 447-456.

PHOSPHORUS

I. BIOLOGICAL EFFECTS. Phosphorus is an essential nutrient which frequently occurs in minute quantities in natural waters and can thereby be limiting to the growth of aquatic plants. When present in excess, however, under favorable environmental conditions, it is instrumental in producing heavy and undesirable growths of both algae and rooted aquatic plants. Results obtained by various workers (e.g., Sawyer, 1947; Chu, 1943; Strickland, 1965; and Sylvester, 1961) indicate that phosphorus does not become limiting to algae until concentrations as low as 0.01 mg/l or less of soluble phosphorus are reached.

II. SPECIAL CONSIDERATIONS. Phosphorus, in increased quantities, is commonly associated with accelerated lake eutrophication. The degree to which aquatic plant growth is stimulated by phosphorus is variable, and will depend on the occurrence of other essential nutrients, temperature, light, etc. Phosphorus is, however, a substance which is essential to plant growth, one which is frequently limiting, and one which is much more amenable to control than many other nutrients. Nitrogen, for example, is difficult to control because some forms of algae are able to fix atmospheric nitrogen.

III. EXISTING CONDITIONS. Data on phosphorus distribution in Lake Superior are scarce. A synthesis of data published by Putnam and Olson (1960) and by Beeton, et al. (1959), indicate average distribution of total phosphorus, as mg/l Phosphorus, for all depths, to be as follows:

West End (West of Apostle Islands)	0.009
Apostle Islands Region	0.014
Open Lake, Apostle Islands to Keweenaw Peninsula	0.010
Keweenaw Bay	0.011
Coastal Waters off Marquette and Munising	0.010
Open Lake, East End	0.005
Whitefish Bay	0.008

The average for the entire lake is 0.0096 mg/l.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The total phosphorus levels should not be permitted to exceed existing values. Where background data are not available the maximum value should not exceed 0.01 mg/l total phosphorus. The existing level of phosphorus in some areas of Lake Superior is greater than the proposed 0.01 mg/l maximum limit and is cause for concern. Every effort should be made to reduce phosphorus inputs into the Lake. Recommended as guideline.

V. REFERENCES.

1. Beeton, A.M., J.H. Johnson, and Stanford H. Smith. 1959. Lake Superior Limnological Data. U.S. Fish and Wildlife Service. Special Scientific Report – Fisheries No. 297, Washington, D.C., 177 p.

2. Chu, S.P., 1943. The Influence of the Mineral Composition of the Medium on the Growth of Planktonic Algae. Part II. The Influence of the Concentration of Inorganic Nitrogen and Phosphate Phosphorus. J. Ecology, 31:109.

3. Putnam, H.D., and T.A. Olson. An Investigation of Nutrients in Western Lake Superior. School of Public Health, University of Minnesota, Duluth, for the Minnesota Water Pollution Control Commission, 1960.

4. Putnam, H.D., and T.A. Olson, 1966. Primary Productivity at a Fixed Station in Western Lake Superior. Proceedings, Ninth Conf. on Great Lakes Res., Inst. of Sci. and Tech., University of Mich., Ann Arbor, p. 119-128.

5. Sawyer, C.N., 1947. Fertilization of Lakes by Agricultural and Urban Drainage. J. NEWWA, 61:109.

6. Strickland, J.D.H., 1965. Production of Organic Matter in the Primary Stages of the Marine Food Chain. Chemical Oceanography (J.P. Riley and D. Skirrow, eds.), Academic Press, New York.

7. Sylvester, R.O., 1961. Nutrient Content of Drainage Water from Forested, Urban, and Agricultural Areas. Algae and Metropolitan Wastes, Public Health Service, SEC TR W61-3, 80, U.S. Govt. Print. Off., Washington, D.C.

IRON

I. BIOLOGICAL EFFECTS. Iron causes problems of taste, color and odor in water supplies and may stimulate the growth of bacteria and other lower plant life. It will discolor shore areas and may coat water conduits. Concentrations in excess of 0.3 mg/l cause taste problems and stain laundry. Lesser concentrations in combination with manganese often result in undesirable growths.

II. SPECIAL CONSIDERATIONS. Iron solubility is highly pH dependent. In more desirable pH values of 6.5 to 8.5 it occurs in the oxidized state and is rather insoluble and usually settles. Introductions of iron may result in an increase in settleable solids content in this way. Iron will redissolve in hypolimnionic waters under certain conditions and then may cause taste and odor problems.

III. EXISTING CONDITIONS. The ten year average concentration at Duluth is 0.023 mg/l and 0.019 mg/l at the St. Mary's River. The high value recorded is 0.168 mg/l. Highest readings occurred during the last several years.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The maximum value should be 0.1 mg/l and 90% of the values should be less than 0.03 mg/l at any single location.

V. REFERENCES.

1. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C. April 1968.

2. U.S. Department of Health, Education and Welfare, 1962, Public Health Service Drinking Water Standards, PHS Publication No. 956.

3. Water Quality Criteria, California State Water Quality Control Board, Sacramento, California, Publication 3-A, 1963. pp. 215

CADMIUM

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. BIOLOGICAL EFFECTS. Cadmium occurs in small amounts in naturally occurring inc ores reflecting its close chemical relationship to zinc but in natural waters ccurs in only trace amounts. Cadmium is a nonessential, nonbeneficial element. t is a heavy metal that accumulates in animal tissues and has a high pollution otential because of its high toxicity and cumulative effects.

In the U. S. Public Health Service Drinking Water Standards, cadmium in xcess of 0.010 mg/l constitutes grounds for rejection of the supply. Long term oxicity studies conducted at the Federal Water Quality Administration's Newtown ish Toxicology Laboratory have shown slow accumulative mortality in young fish and hat newly hatched fry are extremely sensitive to cadmium. These chronic studies onducted in hard water (in which cadmium is less toxic than in Lake Superior) ave a "safe" concentration of 0.037 mg/l. The test concentration of 0.057 mg/l was ethal to newly hatched fry.

Recent work by the Federal Water Quality Administration's National Water uality Laboratory using numerous three generation experiments (nine (9) weeks) with *aphnia magna* have shown concentrations of cadmium between 1.8 and 3.2 ppb to esult in eventual mortality to all animals. Snail (*Physa sp.*) eggs and midge *Tanytarsus dissimilis*) larvae are also killed at these concentrations.

Cadmium concentrations between 0.7 and 1.9 ppb result in partial kills to . *magna* and significantly fewer young born during the third generation. In additi idges and snails are adversely affected.

A safe cadmium level for the above animals is below 0.5 ppb.

I. SPECIAL CONSIDERATION. The toxicity of cadmium, like the other heavy metals, s influenced by water quality characteristics, such as pH and hardness. Acute oxicity studies indicate that the lethal concentration of cadmium in softer water s 1 mg/l.

II. EXISTING CONDITIONS. According to Kopp and Kroner, of 66 samples in the 'estern Great Lakes Basin the frequency of detection (0.45 millipores filtered samples) 'as 3%. They did not detect cadmium in Lake Superior.

V. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The recommended criteria for cadmium n Lake Superior is a maximum value of 0.0005 mg/l

'. REFERENCES.

1. Pickering, Q. H., and Gast, M. The Chronic Toxicity of Cadmium to the Fathead Minnow (Pimephales promelas) (In preparation).

2. Pickering, Q. H. and Henderson, C. Acute Toxicity of Some Heavy Metals to Different Species of Warm Water Fishes, Proceedings 19th Industrial Waste Conference. Purdue University. 1965.

CHROMIUM

I. BIOLOGICAL EFFECTS. In the U.S. Public Health Service Drinking Water Standards the presence of hexavalent chromium in excess of 0.05 mg/l shall constitute grounds for rejection of the supply. Chromium is not known to be either an essential or beneficial element in animals. There is accumulation of chromium in many animals and when inhaled, chromium is a known cancerigenic agent for man. Trivalent chromium is not of concern in drinking water supplies at present.

In long-term tests conducted at the Federal Water Pollution Control Administration's Newtown Fish Toxicology Laboratory, in a hard water, 1 mg/l of hexavalent chromium was found to be a "safe" concentration for survival and reproduction of the fathead minnow. The lethal value in a similar water (200 mg/l hardness) was 33 mg/l. In a soft water, low pH bioassay the lethal value for the fathead minnow was 17 mg/l.

Bioassays conducted with four species gave lethal values of hexavalent chromium that ranged from 17 to 118 mg/l. Thus it appears that there is a great range of sensitivity of various fish species. Hexavalent chromium appears to be more toxic to some invertebrates; 0.05 mg/l is lethal to Daphnia, a very important animal in Lake Superior. In acute bioassays trivalent chromium is more toxic in soft water than hexavalent chromium. The chronic studies indicated that their toxicity is not greatly different.

II. Special Considerations. Hexavalent chromium is very soluble in water while trivalent chromium is much less soluble, especially in hard water. Many variables influence the toxicity of chromium. Trama and Benoit have shown that the toxicity of hexavalent chromium is dependent on pH; it is more toxic under conditions of low pH. The toxicity of trivalent chromium is dependent on concentration, pH, hardness, and equilibrium state.

III. EXISTING CONDITIONS. Hexavalent chromium concentrations found in Lake Superior at Duluth had a frequency of detection of 40%. In these samples of positive occurrence the mean concentration was 9 μg/l and the maximum was 20 μg/l. At St. Mary's River hexavalent chromium was found in 17% of the samples with a mean of 3 μg/l and a maximum of 7 μg/l. Data are not available for trivalent chromium concentrations.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The recommended criteria for total chromium is a maximum of 0.050 mg/l and 90% of the values should be less than 0.02 mg/l at any single location.

V. REFERENCES.

1. Pickering, Q. P., and Henderson, C. Acute Toxicity of Some Heavy Metals to Different Species of Warmwater Fishes, Proceedings 19th Industrial Waste Conference, Purdue University, 1965.

2. Trama, F. B., and Benoit, R. J. Toxicity of Hexavalent Chromium to Bluegills, Journal Water Pollution Control Federation, Volume 32, 1960.

COPPER

I. BIOLOGICAL EFFECTS. Copper is one of the more toxic of the heavy metals to many desirable aquatic organisms. It is also an essential trace element and is often added to the foods of both aquatic and terrestrial animals. It is commonly used to control algal growths in water supplies. The permissible concentration in public water supplies is 1 mg/l and the desirable concentration is virtually absent.

Experiments with trout, perch, sunfish, freshwater shrimp, Daphnia, snails, and clams establish the maximum no-effect concentrations in Lake Superior water to be between 0.01 and 0.05 mg/l. Trout, shrimp, and Daphnia, all important in Lake Superior, are among the most sensitive. To some animals, copper concentrations that kill are substantially higher than concentrations that retard growth and inhibit reproduction. Experimentation has shown that concentrations 1/10 to 1/30 of the lethal concentrations inhibit reproduction.

II. SPECIAL CONSIDERATION. Both pH and the calcium-magnesium content of water affects copper toxicity to aquatic organisms. The lethal concentrations are more affected by these characteristics than are the no-effect concentrations. Lake Superior water has low concentrations of calcium and magnesium and therefore copper is more toxic in it than in most other natural waters of the United States. For this reason, stringent criteria are needed.

III. EXISTING CONDITIONS. Five year average concentrations of copper at Duluth and the St. Mary's River are 0.003 and 0.005 mg/l, respectively. Some values have been reported as high as 0.02 mg/l, but nearly all are less than 0.01 mg/l. Except near sources of copper introduction, concentrations do not vary greatly.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The criteria for Lake Superior should be a maximum of 0.012 mg/l and 90% of the measurements should be less than 0.008 mg/l at any single location.

V. REFERENCES.

1. Sprague, J. B., Lethal Concentrations of Copper and Zinc for Young Atlantic Salmon, Journal of Fisheries Research Board, Canada, 21 (1), 1964.

2. Mount, Donald I. Chronic Toxicity of Copper to Fathead Minnows (Pimephales Promelas, Rafinesque). Water Research, 2:215-223, 1968.

3. Grande, Magne., Effect of Copper and Zinc on Salmonid Fishes, Third International Conference on Water Pollution Research, Section 1, Paper No. 5.

4. Sprague, J. B., Avoidance of Copper-Zinc Solutions by Young Salmon in the Laboratory. Journal Water Pollution Control Federation. Vol. 36 (8): 990-1004, 1964.

5. (Personal communication, National Water Quality Laboratory Staff.) Acute and Chronic Effects of Cu^{+2} on Fish and Invertebrates in Lake Superior Water, 1969.

LEAD

I. BIOLOGICAL EFFECTS. Lead is quite poisonous to aquatic organisms, concentrations of 0.1 mg/l having killed fish in soft water. In water more like that of Lake Superior, however, short term (a few hours to a few days) mortality test values of from 5 to 50 mg/l of lead have often been obtained.

The few longer term (up to six months), nonlethal exposures to lead in water have demonstrated that accumulations in various parts of the body result from continuous uptake of lead by the fish. Such accumulations in mammals have led to toxic effects and death after long periods of time, even many years. On the basis of available information on fish, similar results would be expected.

Daphnia in Lake Superior water are killed in a few days by an 0.5 mg/l concentration; mayflies, stoneflies, and caddisflies are killed at 16 to 64 mg/l concentrations.

II. SPECIFIC CONSIDERATIONS: Because of lead's low solubility in comparison with many other metal salts, pH and calcium-magnesium content of water are particularly important in determining its toxicity. High lead concentrations are particularly significant in the soft water of Lake Superior.

III. EXISTING CONDITIONS. The average concentration of lead in filtered water at the St. Mary's River over the five year period ending September 30, 1967 was 0.006 mg/l. Two filtered samples taken at Duluth during this period contained 0.007 and 0.02 mg/l. The average of 20 unfiltered samples taken at scattered sites in Lake Superior during 1967 is 0.027 mg/l. This figure excludes one very high and probably incorrect value of 0.306 mg/l that was found in a sample taken near the center of the lake.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The Public Health Service Drinking Water Standard of 0.05 mg/l should never be exceeded and 90% of the measurements should be less than 0.03 mg/l at any single location.

V. REFERENCES.

1. McKee, J.E., and Wolf, H.W., Water Quality Criteria, Publication No. 3-A, California State Water Quality Control Board, Second Edition, 1963.

2. Pickering, Q.H., and Henderson, C., 1966. The Acute Toxicity of Some Heavy Metals to Different Species of Warmwater Fishes. Air-Water Pollution International Journal 10:453-463.

3. Warnick, S.F., and Bell, H.L., 1969. The Acute Toxicity of Some Heavy Metals to Different Species of Aquatic Insects. Journal of Water Pollution Control Federation. 41:280-284.

4. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C. April 1968.

5. U.S. Department of Health, Education and Welfare, 1962, Public Health Service Drinking Water Standards, PHS Publication No. 956.

NICKEL

I. BIOLOGICAL EFFECTS. The U.S. Public Health Service Drinking Water Standards do not place any concentration limits on nickel. It is a nonessential element, and its toxicity to mammals appears to be very low. However, nickel may be very toxic to some plants.

The lethal concentration of nickel in soft water (20 mg/l hardness) to the fathead minnow is about 5 mg/l and in hard water (360 mg/l hardness) it is about 43 mg/l. With continuous-flow testing the lethal concentration is 20 mg/l in water of 200 mg/l hardness. Using these data, the estimated lethal concentration in Lake Superior water (44 mg/l hardness) would be 7 mg/l of nickel. Some Lake Superior fish are more sensitive, however.

In a long-term bioassay conducted with a water of 200 mg/l hardness at the Federal Water Pollution Control Administration's Newtown Fish Toxicology Laboratory, the "safe" concentration was 0.4 mg/l nickel. At this concentration the fathead minnow lived, grew, and reproduced.

II. SPECIAL CONSIDERATIONS. Certain environmental variables affect toxicity of nickel, but toxicity is not affected by hardness as much as for other metals. Various types of aquatic life differ considerably in sensitivity to nickel.

III. EXISTING CONDITIONS. Concentrations of nickel in the Western Great Lakes Basin were found in 9% of the samples. In the samples with positive occurrence, the mean concentration was 0.01 mg/l and the maximum concentration was 0.028 mg/l. Nickel was not detected at Duluth.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Nickel should not exceed a maximum of 0.03 mg/l and 90% of the values should be less than 0.015 mg/l at a single location.

V. REFERENCES.

1. Pickering, Q. P. and Henderson, C., Acute Toxicity of Some Heavy Metals to Different Species of Warmwater Fishes, Proceedings 19th Industrial Waste Conference, Purdue University, 1965.

ZINC

I. BIOLOGICAL EFFECTS. Zinc is one of several heavy metals occurring almost universally in surface waters. These natural levels of zinc vary greatly and are influenced by minerals in soils and characteristics of the water itself. Zinc is an essential trace metal for aquatic life, yet inhibits fish production at quite low concentrations.

Long-term tests with the fathead minnow in which the fish were continuously exposed to a series of zinc concentrations during the entire life cycle indicate that concentrations significantly inhibiting reproduction are much lower than the lethal concentrations or those that have demonstrated some histological or physiological changes. These studies were conducted in water with higher calcium, magnesium and pH than that found in Lake Superior water and therefore zinc was less toxic under the test conditions. A decrease in reproduction occurred at a zinc concentration of 0.045 mg/l in hard water. Since the test was conducted in a harder water than that of Lake Superior and the toxicity of zinc increases as the calcium-magnesium level decreases, the safe level in Lake Superior is lower than 0.045 mg/l. Zinc partially reduces reproduction over a wide range of concentrations and there is no sharp threshold.

II. SPECIAL CONSIDERATIONS. Many environmental variables affect the toxicity of zinc. Principal examples would be the calcium-magnesium content of the water, pH, temperature, and differential sensitivity of aquatic species. Such factors prohibit the selection of a single criterion for all freshwater environments.

III. EXISTING CONDITIONS. The mean zinc concentration in water taken at the Duluth, Minnesota, water treatment plant was 0.009 mg/l and at the St. Mary's River, o.020 mg/l. The current permissible level of zinc in public water supplies is 5 mg/l. The high values recorded in St. Mary's River are of concern.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Zinc concentrations should not exceed 0.015 mg/l and 90% of the values should be less than 0.010 mg/l. Existing levels of zinc in the St. Mary's River are greater than those proposed and are cause for concern. Every effort should be made to eliminate sources of zinc. Recommended as guideline.

V. REFERENCES.

1. Brungs, W.A. Chronic Toxicity of Zinc to the Fathead Minnow (Pimephales Promelas, Rafinesque). Transcription American Fisheries Society, April 1969.
2. Mount, D.I. The Effect of Total Hardness and pH on Acute Toxicity of Zinc to Fish. Air and Water Pollution International Journal, 10: 49-56 (1966).
3. Skidmore, J.F. Toxicity of Zinc Compounds to Aquatic Animals, with Special Reference to Fish. The Quarterly Review of Biology, 10 (3): 227 (Sept. 1964).
4. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C. April, 1968.

CYANIDE

I. BIOLOGICAL EFFECTS. Cyanide is a highly poisonous chemical and occurs principally from industrial processes. It combines with hemoglobin in blood, forming a rather stable complex, and reduces the oxygen-carrying capacity of the blood. It is poorly removed by normal water treatment processes.

Experiments with trout and bluegills resulted in total kill at 0.05 mg/l and other adverse effects as low as 0.005 mg/l.

The U.S. Public Health Service Drinking Water Standard is 0.2 mg/l and the desirable concentration is virtually zero.

II. SPECIAL CONSIDERATIONS. Cyanide toxicity to aquatic life forms is highly pH dependent. Undissociated hydrocyanic acid is most toxic and this is present in the largest proportion at low pH values. It combines readily with heavy metals and may be more or less toxic than the uncombined form, depending on the particular complex.

III. EXISTING CONDITIONS. Average concentrations at both Duluth and the St. Mary's River are less than 0.001 mg/l.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The maximum concentration should not exceed 0.004 mg/l and 90% of the values should be less than 0.002 mg/l at any location.

V. REFERENCES.

1. Biology of Water Pollution, U.S. Department of the Interior, Federal Water Pollution Control Administration, 1967.

2. U.S. Department of Health, Education and Welfare, 1962, Public Health Service Drinking Water Standards, PHS Publication No. 956.

3. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C. April, 1968.

4. Cairns, John. Notulae Naturae, #361, July 30, 1963.

5. Doudoroff, P. Transactions of the American Fishery Society, Vol. 95, No 1, Jan. 1966.

HYDROGEN SULFIDE

I. BIOLOGICAL EFFECTS. Sulfides in water are the result of natural processes of decomposition in enriched waters, sewage, and industrial wastes such as those from oil refineries, tanneries, pulp and paper mills[1] chemical plants, and gas manufacturing facilities. Sulfides are produced by the action of anerobic organisms on sulfates and organic sulphur compounds. Hydrogen sulfide contributes to taste and odor of water supples that can be detected by man at 0.005 - 0.010 mg/l[2] and taints flesh of aquatic organisms.

Experiments with eggs and fry of trout, walleye, northern pike, suckers, and immature blue gills and fathead minnows indicate lethal concentrations of undissociated hydrogen sulfide to vary between 0.008 - 0.058 mg/l[2]. Trout fry are killed in three days at 0.020 mg/l at high oxygen levels. Freshwater shrimp are more sensitive than fish fry.

II. SPECIAL CONSIDERATION. Hydrogen sulfide decays exponentially with a half life of one hour in oxygenated water.[3] However, it can be evolved into oxygenated water from organic deposits and can be found at lethal concentrations at the bottom-water interface.[1] The toxicity of an effluent may bear no relation to its potential toxicity in organic deposits. Fish eggs, fry, and food organisms are most susceptible. Since most species of sport and commercial value in Lake Superior spawn at depths of 100 fathoms or less,[4] it is important that good water quality be maintained to this depth at the bottom-water interface.

Fish fry are more sensitive to hydrogen sulfide at low oxygen concentrations.[2] The toxicity of sulfide increases markedly with a decrease in pH because there is more undissociated hydrogen sulfide present.

III. EXISTING CONDITIONS. No measurements of dissolved sulfide have been recorded for Lake Superior, however, it is unlikely that any accumulation has occurred since high oxygen levels are found even at 250 meters.

IV. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The recommended criteria is a maximum of 0.02 mg/l and 90% of the values less than 0.002 mg/l as total sulfide measured at the bottom-water interface. Recommended as guideline.

V. LITERATURE CITED.

1. Colby, Peter J., and Smith, Lloyd L., Jr., 1967. Survival of Walleye Eggs and Fry on Paper Fiber Sludge Deposits in Rainy River, Minnesota. Transactions American Fisheries Society 96 (3) 278-296.
2. Unpublished Data, Department Entomology Fish and Wildlife, University of Minnesota, St. Paul.
3. Hayes, F. R., Reid, B. L. and Cammeron, M. L. 1958. Lake Water and Sediment. II. Oxidation-Reduction Relations at Mud-water Interface. Limnology and Oceagrophy 3: 308-317.
4. Unpublished Data, Bureau of Commercial Fisheries, Ashland, Wisconsin.
5. Longwell, J. and Pentelow, F. T. K. 1935. The Effect of Sewage on Brown Trout (Salmo trutta L.) Journal Exp. Biology 12: 1-12.

TASTE

I. GENERAL CONSIDERATIONS. Tastes and odors affect principally municipal water supplies and beverage industries. In places, tainting of fish flesh occurs and causes impairment of the water for fish production. Great expense is incurred at some treatment plants in other areas of the country because activated carbon treatment is needed to remove tastes and odors.

II. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. In order to avoid expensive water treatment in the future and to protect fishery resources substances causing taste should not be permitted. Chloroform extracts should not exceed a maximum of 0.05 mg/l and 90% of the values should be less than 0.03 mg/l. No discharge that will produce an off-flavor in drinking water nor impart a taint to fish flesh will be permitted.

III. REFERENCES.

1. U. S. Department of Health, Education and Welfare, 1962, Public Health Service Drinking Water Standards, PHS Publication No. 956.
2. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D. C. April 1968.
3. Microbiology for Sanitary Engineers. McKinney. 1962.
4. Duluth Municipal Water Supply. Ten Year Composite Log Annual Reports. Duluth, Minnesota. 1968.
5. Quality of Waters, Minnesota - a Compilation - Taste and Odor, 1955 - 1962. State of Minnesota, Department of Conservation, Division of Waters, Bulletin 21, June 1963.

TEMPERATURE

I. GENERAL CONSIDERATIONS. Temperature affects all physical, chemical, and biological processes in Lake Superior. If the normal temperature regime is altered the complete balance of the lake will be changed. An increase in temperature is known to accelerate the aging process of lakes, increase the toxicity of chemicals, lower dissolved oxygen levels, increase algal growths, disrupt delicate biological cycles, and endanger many important sensitive organisms.

Increases in the water temperature of Lake Superior will require more stringent water quality standards for other parameters.

II. BIOLOGICAL EFFECTS. The valuable lake trout, herring and whitefish of Lake Superior require cold water for their survival. Complete mortality of developing embryos is known to occur at 12° C (54° F.). Significant reduction in hatch occurs above 60° C (43° F.) among the coregonid fishes. Most of the important fish in Lake Superior spawn in the fall (Oct., Nov., Dec.) in response to falling temperatures, requiring temperatures of about 10° C (50° F.) or less to initiate the response. Incubation of the eggs which are found on the lake bottom is best below 6° C (43° F.). Optimum incubation occurs at 0.5° C (33° F.) for the lake whitefish (Coregonus clupeaformis) and 2° C (36° F.) or less for the lake herring (C. artedi). Upon hatching in the spring the young fish move into surface waters and at this time exhibit greater temperature tolerance than the incubating eggs. Exposure to temperatures of 15° C (59° F.) will be tolerated by lake herring fry for extended periods without increased mortality rates. Temperature between 18 - 21° C (64-70° F.) will be tolerated for lesser periods but extended exposure to these temperatures increases rate of mortality markedly.

III. SPECIAL CONSIDERATIONS.

A. Heated effluents should not contribute to temperatures of water so as to cause them to serve as barriers to the movement of anadrumous fish to and from their spawning and rearing areas.

B. Discharge of heated effluents should be to the epilimnion, unless a special study indicates a more desirable discharge point, because the important fish species in Lake Superior are deep water dwellers much of the time.

IV. EXISTING CONDITIONS. Lake Superior is a cold clear, oligotrophic lake. It usually does not exhibit well defined temperature stratification until mid-July and even then the stratification is not uniform from area to area and the thermocline is poorly developed. The lake may mix to great depths and homothermous water around 2° C (36° F.) has been found to occur to depths of 600 ft. The deep water remains near 4° C (39° F.) through the year. Yearly average temperatures from Duluth and St. Mary's River are 8.5° C (47° F.) and 7.3° C (45° F.).

Nine year average temperatures at St. Mary's River, given as quarterly averages are:

		Average of Quarterly Mean	Average of Quarterly Maximum
I.	(Jan., Feb., Mar.)	- 0.7° C (33° F)	2.3° C (36° F)
II.	(Apr., May, June)	- 5.5° C (42° F)	14.9° C (59° F)
III.	(July, Aug., Sept.)	- 16.0° C (61° F)	20.4° C (69° F)
IV.	(Oct., Nov., Dec.)	- 7.0° C (45° F)	13.8° C (57° F)

Average temperatures along the North Shore and mid-lake are below these temperatures while averages for areas along the South Shore (Calumet, Marquette, etc.) are similar and occasionally somewhat higher.

These are the maximum values for Lake Superior obtained from the literature as referenced.

I.	(Jan., Feb., Mar.) -	Mean	1.3° C	(34° F)	Soo (St. Mary's R.)	1965 NWQN
		Max.	2.8° C	(37° F)	Marquette	1954 Beeton
II.	(Apr., May, June) -	Mean	6.8° C	(44° F)	Soo (St. Mary's R.)	1964 NWQN
		Max.	17.2° C	(63° F)	Calumet	1955 Beeton
III.	(July, Aug., Sept.) -	Mean	17.9° C	(64° F)	Soo (St. Mary's R.)	1966 NWQN
		Max.	25.0° C	(77° F)	Calumet	1953 Beeton
IV.	(Oct., Nov., Dec.) -	Mean	7.6° C	(46° F)	Soo (St. Mary's R.)	1963 NWQN
		Max.	13.9° C	(57° F)	Calumet	1953 Beeton

V. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. There shall be no increase in the temperature of the open water of Lake Superior above natural background levels. Appropriate numerical values for temperature will be established at a later date pending evaluation of additional data. Recommended as guideline.

VI. REFERENCES.

1. Beeton, A.M., Johnson, J.H. and Smith, S.H., 1959. Lake Superior Limnological Data. U. S. Fish and Wildlife Service Special Science Report - Fisheries No. 297, Washington, D. C., 177 pp.
2. Breeder, C. M. Jr., and Rosen, D. E., 1966. Modes of Reproduction in Fishes, American Museum of Natural History, Garden City, New York.
3. Dryer, W.R., 1966. Bathymetric Distribution of Fish in the Apostle Island Region of Lake Superior. Transactions of American Fisheries Society. 95 (3): 248-259.
4. National Water Quality Laboratory: Thermal Studies, 1966-1969. Unpublished Data.
5. National Water Quality Network (1957-1968) Annual Compilation of Data. (Storet Retrival System). U. S. Department of Health, Education and Welfare, Washington, D. C.
6. Price, John W., 1940. Time-temperature Relations in the Incubation of the Whitefish, Coregonus clupeaformis (Mitchill). Journal General Physics (4) 23: 449-468.
7. Ruschmeyer, O.R. and Olson, T.A., 1958. Water Movements and Temperatures of Western Lake Superior. School of Public Health, University of Minnesota, for Minnesota Water Pollution Control Commission, 86 pp.
8. Tait, J. S., 1960. The First Filling of the Swim Bladder in Salmonids. Canadian Journal of Zoology. 38: 179-187.
9. Wells, LaRue, 1966. Seasonal and Depth Distribution of Larval Bloaters (Coregonus hoyi) in Southeastern Lake Michigan. Transactions of American Fisheries Society. 95 (4); 388-396.

pH

I. GENERAL CONSIDERATIONS. Most organisms of esthetic and commercial importance live in water within an extremely narrow pH range. The pH concentration is governed by many inorganic chemicals and biological processes. Excessive additions of domestic or/and industrial wastes result in pH changes and can therefore make water unsuitable for desirable organisms. Thus it is important to control pH which in turn will regulate other water quality parameters.

II. BIOLOGICAL EFFECTS. Rudolfs, et. al. (1953) states that a pH range from 6.5 to 8.4 is tolerated by most fish. Chandler (1940) suggests values between 7.5 to 8.4 to be best for plankton production. Ellis (1937) found that most inland waters having fish have pH values between 6.7 and 8.6. Hart, et. al. (1945) report that only 5% of the waters in the United States supporting a good fish population have pH less than 6.7 whereas 95% have a pH less than 8.3. Parsons (1968) found the greatest number of species of plankton, benthos, and fishes to be in stream sections with a pH of 6.8 and above.

Work with pH at the National Water Quality Laboratory suggests that pH values below 6.0 inhibit or reduce spawning success with fathead minnows, and are lethal to *Daphnia magna* and new *Gammarus pseudolimnaeus*.

III. SPECIAL CONSIDERATIONS. Permissible criteria for public water supplies given in Water Quality Criteria (1968) give a range of pH from 6.0 - 8.5.

IV. EXISTING CONDITIONS. Lake Superior is an oligotrophic lake low in total dissolved solids and rather poorly buffered. Beeton (1959) gives pH values ranging from 6.9 to 8.0 in 1953 for samples taken at various depths in the open lake; however, most values were between 7.3 and 7.7. The maximum, minimum and mean pH values in Lake Superior were:

	Lake Superior at Duluth	St. Mary's River at Saulte Ste. Marie
Years	1958 - 1968	1960 - 1968
No. Samples	543	457
Maximum	8.5	8.3
Minimum	7.3	6.8
Mean	7.7	7.8

V. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. The pH in Lake Superior should remain between 6.8 and 8.5. The objective is to not allow a trend from existing mean values.

VI. REFERENCES.

1. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1968.
2. Beeton, A.M., J.H. Johnson, and S.H. Smith, 1959. Lake Superior Limnological Data. U.S. Fish and Wildlife Service Special Science Report -- Fisheries No. 297, Washington, D.C., 177 pp.
3. Chandler, D.C., 1941. Limnological Studies of Western Lake Erie. I. Plankton and Certain Physical-Chemical Data on the Bass Islands Region, from September 1938 to November 1939. Ohio Journal of Science 40, 291.
4. Ellis, M.M., 1937. Detection and Measurement of Stream Pollution (Related principally to fish life). U.S. Department of Commerce, Bureau of Fisheries Bulletin 22.
5. Hart, W.B., P. Doudoroff, and J. Greenbank. 1945. Evaluation of Toxicity of Industrial Wastes, Chemicals and Other Substances to Freshwater Fishes. Water Control Laboratory, Atlantic Refining Company, Philadelphia, Pennsylvania.
6. Parsons, J.D., 1968. The Effects of Acid-Strip-Mine Effluents on the Ecology of a Stream. Arch. Hydrobiol. 65(1):25-50.
7. Rudolfs, W., et. al. 1953. Industrial Wastes. Reinhold Publishing Company, New York.

RADIOACTIVITY

I. GENERAL CONSIDERATIONS. There are at present no numerical radiological criteria directly applicable to the open waters of Lake Superior. Releases of radioactive materials to the lake (or otherwise) are regulated, however, by license by the Atomic Energy Commission.[1] Concentration of radionuclides in food and water used in interstate commerce, derived from the lake, are regulated by the U.S. Public Health Service. In addition, State and local regulations limit the concentrations permitted in public drinking waters.

The Federal Water Pollution Control Administration has been working with the Atomic Energy Commission and the U. S. Public Health Service to develop model radiological criteria for water. These criteria will apply to receiving waters, as different from waste effluents which are regulated by the Atomic Energy Commission as noted above. These criteria will be composed of three parts designed for the protection of human health as it may be affected through (1) drinking water, (2) waters used for recreation and other purposes involving potential human contact with or ingestion of water, and (3) waters used for the production or processing of food for human consumption (i.e. fish, shellfish, irrigated crops, milk, etc.).

After a draft of the criteria, developed at staff level through the joint effort of these three Federal agencies, has been reviewed and officially endorsed by each agency, it will be submitted to the Federal Radiation Council, the Conference of State Sanitary Engineers and an appropriate organization of the State radiological health officers for review, comments and hopefully, endorsement. This process may require up to a year to complete.

II. EXISTING CONDITIONS. The 12 year average gross beta radioactivity at Duluth is approximately 9.5 picocuries/1, including several years of active atmospheric bomb testing (and accompanying fallout). Radioactivity levels since 1965 have averaged less than 3.5 picocuries/1.

The similar 12 year average for total alpha activity, which includes radium and other naturally occurring radionuclides, is approximately 0.12 picocuries/1.

Similar averages were obtained at the St. Mary's River station.

III. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. Proposed radiological criteria will be deferred pending development of model criteria by Federal Water Quality Administration, Atomic Energy Commission and U.S. Public Health Service. When these model criteria are published an appropriate review will be made that time to determine their suitability for the open waters of Lake Superior.

IV. REFERENCES.

1. U. S. Atomic Energy Commission, Part 20: Standards for Protection Against Radiation, Federal Register 25 (224): 10914-10924. November 17, 1960.
2. National Committee on Radiation Protection, Report of Ad Hoc Committee, Somatic Radiation Dose for General Population, Science 131:482. February 19, 1960.
3. Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposures. Handbook No. 69, National Bureau of Standards, Washington, D.C. 1959.
4. Background Material for the Development of Radiation Protection Standards. Staff Report, Federal Radiation Council, Washington, D.C. July 1964.
5. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D.C., April 1968.

ALL OTHER POLLUTANTS

I. GENERAL CONSIDERATIONS. Application factors provide a rational basis for estimating safe concentrations of pollutants utilizing easily obtained lethal values and are especially useful for establishing safe concentrations of mixed effluents. The procedures to be followed in deriving application factors are discussed on pages 58 and 59 of the Report of the National Technical Advisory Committee on Water Quality Criteria and a brief outline follows.

As the report points out, a great difference usually exists between the toxicant concentration that kills in a few days and the concentration that is just barely safe over one or more entire life cycle periods of continuous exposure to the toxicant. An application factor is composed of the ratio or fraction derived by relating, for a given pollutant, the mortality data from a four day toxicity test to the just safe concentration for the entire life cycle. This factor can subsequently be used to estimate environmental concentrations of this toxicant that are safe for different species of fish or in different water types. One does this by multiplying the application factor for the pollutant by the toxicity data obtained from a four day test with the new species or water type. A different application factor must be calculated for each pollutant.

Thus, application factors are important because they eliminate the necessity of having to expose entire life cycles of all species in all water types. They have varied from 1/7 to 1/500 for different pollutants that have been tested.

II. RECOMMENDED CRITERIA FOR LAKE SUPERIOR. In the absence of specific information, safe concentrations of pollutants should be:

1. For nonpersistent pollutants or those that have noncumulative effects, the environmental concentration should not exceed 1/10 of the 96-hour TL_m level at any time or place, and 90% of the measurements should not exceed 1/20 of the 96-hour TL_m value.

2. For other toxicants the environmental concentrations should not exceed 1/20 and 1/100 of the 96-hour TL_m level under the conditions described in (1) above.

3. Proportional reductions should be made in the permissible concentrations of pollutants when they are known to affect or add to the toxicity of other pollutants present in the water.

III. REFERENCES.

1. Water Quality Criteria, Report of the National Technical Advisory Committee to the Secretary of the Interior, Federal Water Pollution Control Administration, Washington, D. C., April 1968.
2. Mount, D.I., and C.E. Stephan, 1967. A Method for Establishing Acceptable Toxicant Limits for Fish--malathion and the butoxyethanol ester of 2, 4-D. American Fish Society, Trans. 96(2): 185-193.

MR. STEIN: I am going to open this to comment or questions.

First I would like to make a statement, and this is directed particularly to all the panel and to all this, and I would like this to be off the record.

(Off the record.)

MR. STEIN: Let's go back on the record and throw this open again for questions or comments.

MR. MAYO: Mr. Chairman, I would like to compliment the committee for responding to what was in fact a very difficult assignment. The committee was given the task to develop,for a lake as pristine as Lake Superior, some recommended water quality criteria which in the opinion of the committee members would not only retain that pristine quality, but also meet the water-use characteristics that have been identified by the individual States and by this conference. They were given the difficult task of reducing these recommendations to specific numbers in the face of what are existing excellent water quality conditions in Lake Superior.

I think it would be appropriate for us to examine, at least in an initial way, the extent to which the recommended criteria differ from existing quality in

Lake Superior and to touch on, at least, today the significance of that difference and how it relates to the responsibilities of the conferees, because what is being recommended here is that the conferees accept these criteria as being reasonable and as conferees refer them to the individual States for State adoption and inclusion as essentially uniform water quality parameters for Lake Superior.

During that process, each of the States will have the opportunity, under State law, to hold public hearings and to examine each of the proposed criteria in whatever detail the public wishes to address itself to those individual parameters.

I think it would be worth a few minutes this morning to just select a few of these and to make at least some initial observations with regard to them.

The audience doesn't have this material. Appended to the report that was submitted to the conferees is an identification of the rationale, so to speak, that is associated with each of these indicated parameters, and the rationale addresses itself to the significance of that parameter, any special considerations associated with it, existing conditions in Lake Superior, and the recommended criteria.

(Which said material appears herein at pages 94 to 135, inclusive.)

An examination of the existing conditions versus the recommended criteria by someone who was not versed in what the significance of the range of difference might be could, I think, lead to some inappropriate conclusions. In several instances the recommended criteria are higher values than those which presently exist in Lake Superior. Taken in a percentage sense, these might be interpreted as gross differences. Taken, however, in the sense of the real significance of these differences, we would still be talking about excellent quality of water in Lake Superior. I think the opportunity needs to be available to the conferees to address themselves in some detail to each of these recommended criteria.

For instance, with respect to ammonia, the existing conditions are identified in the report as ranging from 0.0 to 0.1 milligrams per liter of ammonia nitrogen, and means of 0.071 and 0.0024 milligrams per liter, respectively, for Sault Sainte Marie and Duluth. The recommended criteria is 0.1 milligrams per liter expressed as ammonia nitrogen as the maximum and 90 percent of the time less than 0.05.

Well, if we relate these figures to the earlier ones given as the means, it appears that we are departing by an order of magnitude or two with respect to ammonia nitrogen, but yet in a practical sense that departure, in terms of the quality, relative pristine quality, of Lake Superior may really not be significant.

We have somewhat the same situation with regard to the parameters of phosphorus and iron, cadmium, chromium, and others of the heavy metals.

The substance of these recommendations I feel, Mr. Chairman, are of great importance to the conferees, because they would in turn be expected to recommend to the people of their individual States that these be adopted and be made a firm part of the State standards.

I would like to suggest to the conferees that they give some consideration to the desirability of addressing themselves collectively to these recommendations before addressing themselves individually to the recommendations in the context of their State hearings, which would be required if they choose to present these as prospective State water quality criteria, and to consider doing that collective examination in the context of the enforcement conference, either through the medium of a workshop for the conferees, which would be open to the public to sit and listen to the conferee deliberations, or to take the example that was recently used in the Lake Erie enforcement conference of having a workshop through which the public would be asked to comment on these specific criteria and to take the report from the committee, accept it without action, reserve judgment on it, and offer it to interested parties for their review and consideration and an opportunity to later come back to the conference and make specific comment with regard to the individual parameters.

MR. STEIN: Any other comment to that suggestion?

MR. BADALICH: Mr. Chairman.

MR. STEIN: Yes, Mr. Badalich.

MR. BADALICH: I believe you may recall at the last session the Minnesota conferees recommended a motion for the adoption of these recommendations, but we were ruled out of order at that particular time. I am willing again this morning to make such a motion or at least some recommendation that the conferees do adopt these recommendations of the Water Quality Technical Committee in their entirety and then in turn go through the necessary public hearings where we will have a public forum at that particular time to get the view of the interested citizens, and so on, and finally adopt these as the States water quality standards.

MR. STEIN: Again, Mr. Badalich, if I understand you and Mr. Mayo, and I think I do, I first want to commend the technical committee and you on doing an excellent job in a very, very difficult and technical area. The point is we are faced with a philosophic question. Mr. Mayo sees that the adoption of these suggested standards, as developed by the technical committee, may bring up the view that if they are adopted as written it may run smack into the anti-degradation clause that we have in the standards and certainly that we are considering on the Federal level.

What he is saying--and I think we will find when we cut through all this technical material because this is a very technical subject--is that some of the limits recommended here contain more in the materials, for example ammonia, several of the others, than naturally exist in Lake Superior now. The question is whether we are degrading that. In most cases, I think it is fair to say that it might be argued that the differences are very, very small and some people might not consider them significant.

It seems to me we have a basic philosophic question. I say this because one of the many hats I wear is working on the standards while the States are approving them and getting them approved on the Federal level. The question I noted I am going to get is that if the standards come in to me with a recommendation or a note from Mr. Mayo from this Region saying that there is a question of whether the adoption of these standards would permit a degradation of the waters of Lake Superior, where do we go from there?

Mr. Mayo's suggestion is that we sit down and try to meet those problems first, before you get this package to the States for adoption.

Have I stated this reasonably well on your position?

MR. MAYO: Yes.

MR. STEIN: I would like your views on this, because I don't know where to go.

MR. PURDY: Mr. Stein, I think, among other things, that we ought to recognize where we now are, and the report addresses itself to this problem to some extent. The technical committee has found that the existing water quality standards that have been adopted by the various States for Lake Superior were designed to protect the waters near the shore of the lake and that if these waters are fully protected from adverse quality effects the open waters of Lake Superior or the general quality of the lake will not be degraded.

So I think we are farther along the line than what some people may think that we are, because the committee's recommendations now deal with the open water. They have also reached the conclusion that the existing water quality standards that have been adopted by the various States will protect those open waters so that they will not be degraded. So that we are a long ways down the line right at the present time.

As far as this report, I am not sure when we say we adopt the recommendations of the committee what we are adopting. There are the recommendations from the standpoint of the numerical values and then on page 12 of the report there are some five recommendations. I feel that we are in a position, though, where the conferees could accept the report of the technical committee and that the report be referred to the various States for action under State law.

MR. STEIN: Mr. Mayo, do you want to speak to that?

MR. MAYO: Part of my concern, Mr. Purdy, is that I would not want to find myself, as the Federal Conferee, recommending that the report in its present form go to the States having been accepted by the conferees unanimously, with the anticipated guarantee that if these numbers are in fact incorporated into the State water quality requirements and pumped back up through the Department of the Interior that the Secretary is going to sign off on those criteria and approve them, even though they may have previously been accepted and in a sense acquiesced to by the Federal conferee.

So I am suggesting, in part for that reason and in part for the personal conviction, that a collective discussion on this, either before the public or with public participation, would be desirable before the recommendations were accepted by the conferees and transmitted to the States for their inclusion in State water quality standards, with the very good prospects and assurance that the Department of the Interior would be in the position to finally approve these once they are adopted by the individual States.

MR. STEIN: And that time will be E.T.A. (Laughter.)

O.K., go ahead.

MR. PURDY: Mr. Stein, I don't know how we can guarantee that the various States are going to adopt what the conferees approve here.

MR. MAYO: Right.

MR. PURDY: Otherwise, I mean, what is the purpose of holding a public hearing at the State level? The purpose of the public hearing at the State level is to receive in the record, the public record, the comments that we are asking and also for the various individual pollution control agencies then to exercise their separate judgment.

MR. STEIN: I understand that.

Let me try this--try to get this resolved, because I think we can go this way.

I want to suggest, one, that I think--let me give you Mr. Mayo's point as I see it. He is suggesting that he doesn't want to be on record as a Federal conferee or to put me in the position of telling you to go to your States with a recommendation. We know we are going to be the same cast of characters, Mr. Mayo with the Region, and then you are going to send it in to me in Washington, where I am going to tell you that just what you have here isn't going to make the grade.

Now, I think we have two proposals. We have a proposal from Mr. Badalich that we ask the States to take this up in the hearing process. We have Mr. Mayo's proposal that we try to get these things resolved at either a workshop with the public viewing it or with public participation.

I would suggest that we recess for lunch, that you caucus on this matter if you see fit. I will call it up and we should be able to resolve it, because I don't think you are going to get any closer by a prolonged discussion here one way or the other. As I see it, either Mr. Badalich will withdraw his motion or we will move on that first and then we will take up the proposal of Mr. Mayo, and if you arrive at a compromise solution, I will be glad to announce that.

With that--

MR. BADALICH: Mr. Chairman.

MR. STEIN: Yes.

MR. BADALICH: Before you recess.

MR. STEIN: Yes.

MR. BADALICH: My recommendation was that we adopt the recommendations as spelled out here on page 12, which will give us the necessary procedures for State hearings and we get into the discussion with all interested parties in our particular State, and I am sure we will invite the FWQA, as we always have, to participate in our hearings, and I think we will get all the frank discussion we need at that particular time.

MR. STEIN: Yes.

MR. BADALICH: I believe now the Water Quality Technical Committee has spent countless hours on this, and I think it is pretty well agreed upon, at least the people on my staff and I am sure with Wisconsin and Michigan and FWQA, that there is agreement that these are very respectable recommendations and guidelines to follow.

MR. STEIN: Let me say, Mr. Badalich, I will assure you, unless you have changed your mind, that I am going to call your question as soon as we come back from lunch.

Now, if there are any further points--I would like this to be unanimous, if we can.

MR. BADALICH: Fine.

MR. STEIN: I would like you to get together or ask Mr. Mayo if he can talk to you and the other States during this lunch and see if we can get some unanimity on this, but I think that would be the best way to handle the matter in order to get it through.

We will stand recessed until 1:30.

(NOON RECESS)

AFTERNOON SESSION

WEDNESDAY, AUGUST 12, 1970

1:30 o'clock

MR. STEIN: We are reconvened.

First we will go to that report of the technical committee. I would like to ask if the consultants here have arrived at a consensus?

MR. BADALICH: Mr. Chairman, I think to start off with I will withdraw my motion.

The conferees from the respective States met during the lunch hour, and I would like to refer this matter to Mr. Purdy, who I believe has a recommendation from this meeting that we had at noon.

MR. STEIN: Thank you, Mr. Badalich.

Mr. Purdy.

MR. PURDY: Yes. We would propose that the conferees accept the report of the Technical Committee and refer it to the States of Michigan, Wisconsin and Minnesota for action to adopt water quality standards for the open waters of Lake Superior to supplement existing standards adopted for inshore waters; that such action should be substantially completed by the next session of this conference; and that each of the States in the conduct of their public hearings are requested to invite the participation of the Department of the Interior, other interested Federal agencies, and the other Lake Superior States.

MR. STEIN: Is that agreeable to all? Are there any comments?

MR. FRANGOS: Mr. Chairman, we agree to this. I think we want to make it clear that we have no quarrel with the numbers that were developed by the technical committee, and our concern here is with uniformity among the States and this is why we propose this recommendation in this form.

MR. STEIN: Are there any other comments?

MR. BADALICH: Mr. Chairman, the Minnesota conferees also concur in this recommendation of Mr. Purdy and we feel the substance is probably the same thing we proposed, but maybe a little difference in wording, but there again we endorse it.

MR. STEIN: Let's call on the Federal conferee for a statement.

MR. MAYO: The Federal conferee has no objection and would go along.

MR. STEIN: If this is the case, let's go on. Will you hold that language for the Executive Session, Mr. Purdy? My guess is you are going to define that in the summary.

I think we will continue with a statement from Minnesota. Again I want to say that if anyone has anything to say, he should indicate to Mrs. Piere that he wants to make a statement. If not, you may find that we have terminated the public session and have gone into Executive Session, and then you may not have an opportunity. So I have asked this many, many times. We have had the floor open for people who want to say something, and if anyone in the future does not get an opportunity to say it, you just didn't register.

Mr. Badalich.

MR. BADALICH: Mr. Chairman, I pass out our report to the rest of the conferees.

JOHN P. BADALICH
EXECUTIVE DIRECTOR
MINNESOTA POLLUTION CONTROL AGENCY
MINNEAPOLIS, MINNESOTA

MR. BADALICH: Mr. Chairman, fellow conferees, ladies and gentlemen.

I will start the presentation for the State of

Minnesota and this will follow through. I have with me today one of the Special Assistant Attorney Generals on my staff, who will probably reiterate and bring you up to date on the current court trial at Two Harbors, and then we will have another witness following him who will present probably some further evidence to the conferees.

I also have a list of a number of the industries and dischargers as well as municipalities from the State of Minnesota that will follow in order after my presentation and these other gentlemen.

As you probably are aware of, the Minnesota conferees are Dr. Howard Andersen, the Chairman of the Agency, Mr. Robert Tuveson, who is a member and former Chairman of the Agency, and myself, the Executive Director of the Pollution Control Agency.

The summary itself relates to the progress towards fulfillment of the recommendations of the conferees since the session of April 29 and 30. The following comments refer to the numbered recommendations of the Federal Water Quality Administration summary of January 26. And this is this document here that was amended from the April 1969 original submission. You may wish to have this summary before you as you follow my comments. You will note that some of the items have been omitted. This is because they were either covered adequately in our previous statement or because the recommendation is not relevant to Minnesota.

1) We support the recommendations of the technical committee on water quality and intend to follow through with public hearings and other procedures necessary for formal adoption of the recommended criteria as water quality standards if such is recommended by the conferees. And I believe this action was just taken, so we will go through the necessary steps of public hearings to take these recommendations and make these a part of our interstate water quality standards.

2) The discharge of taconite tailings has been kept under surveillance to the extent permitted by our resources. Field investigations were made in November 1969 and again this past summer.

3) The Reserve Mining Company on April 13 provided a working progress report on ways of reducing their discharge of tailings to Lake Superior. Copies of the progress report have been made available to the conferees and several other more detailed reports also are available for review. You will recall that the progress report

does not include a time schedule. A schedule has not yet been proposed by the company to our knowledge nor has a final report been furnished, but in a recent letter it was indicated that additional information would be available, probably in November. And Reserve Mining Company is represented today and they will make a statement at this conference.

At the April session it was indicated that the company should select a plan which it believes will meet its obligations in regard to water pollution control and submit such plan to the Agency, and thence to the conferees, for consideration. No such plan has been provided. However, it is understood that the company will appear, as I stated, and present a statement in their behalf. The company currently is challenging our control standards in court, and the Agency has made a counterclaim of violation of the standards and pollution of the lake. The Agency also must hold after this trial a public hearing on possible revocation of the company's discharge permit and may issue an order based on a new effluent standard.

4) The Agency previously reported that a grant application had been prepared to study certain aspects of taconite tailings discharges. During the April session

of this conference Dr. Mount presented information on his studies which indicated he had already covered the ground which we had proposed to study by contract under this grant. In view of Dr. Mount's intensive work in these areas, it was decided that our grant application would be tabled for the time being so as to avoid duplication and that we would undertake other studies on other pollutants in the lake, and this would primarily concern, probably, mercury and getting into the biological activity as well as, probably, algal growth.

At this time we would suggest that the matter of strengthening our water quality surveillance programs be referred to the Water Quality Technical Committee for evaluation of the existing State and Federal programs in relation to the recommended criteria and preparation of recommendations on any desirable changes or expansions of the respective programs.

5) Secondary treatment facilities either have already been provided or satisfactory stipulations have been entered into with the Agency by all municipalities which discharge wastes to and/or affect interstate waters, except for Carlton and Scanlon. And I believe the Agency did take action on Scanlon just this past Monday and this

matter has been resolved insofar as Scanlon is concerned in providing the necessary treatment or joining with the City of Cloquet. We have left this question open to the municipality of Scanlon and this will be resolved in the next 30 days.

However, in both cases engineering consultants have been retained and reports on their preliminary studies already have been submitted. Detailed compliance schedules are given in Attachment A.

6) Disinfection on a year-round basis is provided by all such municipalities except Floodwood, which is now finishing construction of a new waste stabilization pond system. In this case effluent monitoring will be relied upon to determine whether or not the coliform standard is being met whenever an effluent is being discharged. If it cannot be met, installation of chlorination equipment or other suitable measures will be required.

7) The industries which discharge effluents of this kind and are not yet considered in compliance with this requirement include Pickands Mather & Company of Taconite Harbor, Superwood Corp. of Duluth, and the Duluth Works of U. S. Steel Corporation.

The U. S. Steel Corporation has furnished plans and indicated that chlorination facilities will be provided for one outfall late this year. Superwood Corporation has failed to make satisfactory progress in this respect, as well as others, and as a consequence a suit has been filed against the company by the Attorney General. Pickands Mather & Company is conducting engineering studies on soil absorption of the small amount of sewage effluent originating at Taconite Harbor, and preliminary results appear to be favorable. In fact, we just met with the Pickands Mather Company here just the last few days and they appeared and have indicated to us that a stipulation will be entered into and they will come into compliance.

8) Our approved plan for implementing and enforcing the interstate water quality standards includes a requirement for phosphorus reduction by not later than November 1973 for all municipalities discharging to Lake Superior or its bays. All of these municipalities, including Duluth, Grand Marais, Silver Bay and Two Harbors, already have stipulated with the Agency to do this. Discussions are under way with the others which discharge to intrastate and other interstate waters. Hearings already have been held on establishing effluent standards and in

the near future either orders will be issued to the remaining recalcitrants or prosecution will be authorized. The Agency held the necessary effluent standards and enforcement hearings just this past month and I believe orders will be issued sometime in September and October.

The remaining municipalities which will be required to have phosphorus reduction facilities in operation by January 1975 are listed in Attachment B.

9) Only three industries remain which have not yet formally committed themselves to provide secondary treatment or the equivalent by November 1973 and which discharge wastes to interstate waters in excess of the standards. The Minnesota Power and Light Company and Fitgers Brewing Company have recently stipulated.

The status of Reserve Mining Company and Superwood was mentioned earlier. U. S. Steel Corporation has indicated that sewage and phenolic liquors originating at the Duluth Works will be treated by November 1973. Other items, however, remain to be resolved, and it is our intent to proceed as indicated above, either by the issuance of orders or prosecution, so as to achieve effective control of the remaining industrial waste sources in the basin which need some form of phosphorus or other treatment or control. The remaining noncomplying companies are listed in Attachment B.

Incidentally, the United States Steel Corporation will make a statement today.

13) Those municipalities which are believed to have combined sewers and/or major overflows and which discharge to or affect interstate waters are listed in Attachment C. Grand Marais and Two Harbors already have furnished preliminary reports and Floodwood is resolving its problems during current construction of new sewage treatment works. The Agency intends to require the municipalities concerned to proceed with any necessary corrective measures in accordance with the preliminary action plan presented in April. This is shown on Attachment D.

15) The Minnesota Department of Agriculture recently put into effect a regulation restricting the sale and use of the so-called hard pesticides throughout Minnesota. Enforcement of this regulation will provide control against indiscriminate use in the Lake Superior basin and should reduce pesticide losses to surface waters. Further, the Agency has engaged a consultant to monitor pesticides in the Lake Superior basin and field work is under way There are as yet no findings to report.

Briefly summarized, the more significant milestones of progress since April include the signing of stipulations by Duluth, Ely, Fitgers Brewing of Duluth, Grand Marais, Minnesota Power and Light of Duluth, Silver Bay and Two Harbors, and the reaching of an agreement in principle with the U. S. Steel Corporation in regard to a waste improvement program for the Duluth Works, furnishing of preliminary engineering reports or plans by Duluth, Grand Marais, Silver Bay, Two Harbors, and the U. S.Steel Corporation for the Duluth Works, and completion by the Agency of public hearings for establishment of effluent standards and issuance of orders in the near future.

We trust you will agree that significant progress continues to be made. Should any further information be desired, we shall be glad to provide it. Most of the other sources of wastes with which we are involved in this conference have been requested to have representatives present today and can be called upon to report on their progress directly to the conferees.

This concludes my statement, Mr. Chairman.

MR. STEIN: Thank you, Mr. Badalich.

(Attachments to statement follows:)

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality
Section of Enforcement

Status of Scheduled Construction of Treatment
Works for Wastes which are Discharged to and/or Affect
Interstate Waters of the Lake Superior Basin(1)
July 27, 1970

Reproduced from best available copy.

Source and Remaining Control Tasks	Status
Cloquet	
Construction and operation of pilot plant and analysis of data by August 12, 1970.	A preliminary engineering report on joint treatment with the industries has been provided.
Preparation of final basis of design and estimates of costs for treatment facilities by October 12, 1970.	A letter from the city dated February 6 indicates they will proceed with planning for joint treatment with N.W. Paper Co. and Conwed.
Negotiations for final contract for joint treatment facilities by December 12, 1970.	
Preparation of plans and specifications for treatment facilities by November 12, 1971.	
Submittal of plans and specifications to appropriate authorities for approval.	
Advertisement for bids, bid analysis and award of contract, subject to approval of agency granting construction funds by January 12, 1971.	
Agency approval for granting construction funds.	
Construction of treatment facilities by November 12, 1973.	
Conwed Corp., Cloquet	
Construction and operation of pilot plant and analysis of data by August 12, 1970.	A letter dated February 9, from Conwed indicates the company will proceed with planning for joint treatment with Cloquet and N.W. Paper if this method proves to be of least cost to the company.

(1) Includes only those schedules which are incorporated in an order or stipulation.

Source and Remaining Control Task	Status
Preparation of final basis of design and estimate of costs for treatment facilities by October 12, 1970.	
Negotiations for final contract for joint treatment facilities by December 12, 1970.	
Preparation of plans and specifications for treatment facilities by November 12, 1971.	
Submittal of plans and specifications to appropriate authorities for approval.	
Advertisement for bids, bids analysis and award of contract, subject to approval of agency granting construction funds by January 12, 1971.	
Agency approval for granting construction funds.	
Construction of treatment facilities by November 12, 1973.	
Duluth	
Revised engineering report for secondary and tertiary treatment facilities by July 31, 1970.	
Final plans by September 30, 1971.	
Bids and Awards by December 31, 1971.	
Complete construction by November 26, 1973.	
Fitger's Brewing Company, Duluth	
Construction of necessary in-plant changes and diversion of process wastes into the sanitary sewer system by December 31, 1970.	
Grand Marais	
Construction plans for secondary and tertiary treatment facilities by December 30, 1970.	Engineering report has been received and is being reviewed.

Source and Remaining Control Task	Status
Contract awarded for secondary and tertiary treatment facilities by March 30, 1971.	
Secondary and Tertiary treatment facilities completed by September 30, 1972.	
The Northwest Paper Co., Cloquet	
Construction and operation of pilot plant and analysis of data by August 12, 1970.	A letter from the company dated February 6 indicates the company will proceed with planning for joint treatment with Cloquet and Conwed.
Preparation of final basis of design and estimate of costs for treatment facilities by October 12, 1970.	
Negotiations for final contract for joint treatment facilities by December 12, 1970.	
Preparation of plans and specifications for treatment facilities by November 12, 1971.	
Submittal of plans and sepcifications to appropriate authorities for approval.	
Advertisements for bids, bids analysis and award for contract, subject to approval of agency granting construction funds by January 12, 1971.	
Agency approval for granting construction funds.	
Construction of treatment facilities completed by November 12, 1973.	
Silver Bay	
Engineering report on expansion of existing secondary treatment facilities and/or measures to eliminate sources of infiltration and/or stream water influx and tertiary treatment facilities for phosphorus reduction by July 1, 1970.	

Source and Remaining Control Task	Status
Final plans by February 28, 1971.	
Bids and awards by May 30, 1971.	
Complete construction by November 30, 1972.	
Two Harbors	
Engineering report on sanitary sewer infiltration and storm water influx problems by August 1, 1970.	
Final plans by September 1, 1970.	
Bids and Awards by November 1, 1970.	
Final plans on secondary and tertiary treatment works by December 30, 1971.	
Engineering report on secondary and tertiary treatment facilities has been received.	
Bids and Awards by April 30, 1972.	
Complete plant construction by May 26, 1973.	
Complete sewer separation by November, 1979.	

Attachment B

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

Remaining Non-Conforming Sources of Sewage or Industrial Wastes Discharged in the Lake Superior Basin for which Additional Treatment or Control may be Necessary for Compliance with Recommendations of Enforcement Conference.1/

August, 1970

SEWAGE2/

Aurora

Babbitt

Biwabik

Buhl

Carlton

Chisholm

Cloquet

Continental Oil Co.,
Wrenshall Refinery

Eveleth

Floodwood

Fraser

Gilbert

Hibbing

Hoyt Lakes

Iron Junction

Kinney

Leonidas

McKinley

Meadowlands

Minnesota Department of Conservation,
Jay Cooke State Park, Carlton County

Mountain Iron

Nichols Township, St. Louis County

Scanlon

Stuntz Township, Kelly Lake Community,
St. Louis County

Superwood Corporation, Duluth

Thompson Township, Esko Community,
Carlton County

Virginia

Wrenshall

1/ Does not include federal establishments
Requirement primarily is for phsophorus reduction which may include secondary treatment as a prerequisite.

INDUSTRIAL WASTE [3]

Abex Corp., Two Harbors

Continental Oil Co., Wrenshall Refinery

Diamond Tool & Horseshoe Co., Duluth

Reserve Mining Co., E. W. Davis
Works and Power Plant, Silver Bay

Reynolds Foods, Inc., Duluth

Superwood Corporation, Duluth

Two Harbors Power Plant

Union Carbide Company, Duluth

U. S. Steel Corporation, Duluth Works

[3] Requirements may include secondary or equivalent or other treatment and/or phosphorus reduction.

ATTACHMENT C

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

Status of Sewer Separation Studies by Municipalities
Which Have Sanitary Sewers and Discharge to or May Affect Interstate Waters
of the Lake Superior Basin
July 27, 1970

Municipality	Combined Sewers and/or Major Overflows	Year of first Sanitary Sewer Construction	Engineering Report Due By	Study in Progress	Engineering Report Received?	Remarks
Carlton	yes	1914	Oct., 1971(1)	yes	--	--
Cloquet	yes	1905	--	--	yes	--
Duluth	yes	1883	July, 1970	yes	--	Proceeding under HUD grant
Floodwood	yes	Und.	--	--	yes	New treatment works have been constructed and defects corrected.
Grand Marais	yes	1933	--	--	yes	--
Scanlon	Und.	1941	Oct., 1971(1)	--	--	--
Silver Bay	yes	1953	July, 1970	yes	--	--
Two Harbors	yes	1894	--	--	yes	--

Und. - Undetermined

(1) The dates shown are based on the preliminary action plan of April, 1970. As approved by Secretary Hickel, the interstate water quality standards now require completion of works of this type by not later than November, 1979. The other due dates indicated are incorporated in stipulations.

MINNESOTA POLLUTION CONTROL AGENCY
Division of Water Quality

Preliminary Action Plan and Completion Schedule for Construction of Treatment Works to Conform with Recommendations of Lake Superior Enforcement Conference as set forth in Summary of January 26, 1970

April, 1970

Waste Treatment and/or Control Task	Listed in FY 70 I & E Plan with Requirement for Nutrient Reduction(1)	Other Sources which Discharge to or otherwise affect Interstate Waters(2)	Sources which otherwise affect only Intrastate Waters(3)
Effluent disinfection or equivalent	----	May, 1970	May, 1970
Retain consulting engineer	----	Sept., 1970	Sept., 1970
Engineering report on secondary treatment and/or phosphorus reduction	March, 1971	March, 1971	March, 1971
Authorize final plans	April, 1971	April, 1971	April, 1971
Final plans on secondary treatment and/or phosphorus reduction	Oct., 1971	Oct., 1971	Oct., 1971
Engineering report on sewer separation	Oct., 1971	Oct., 1971	Oct., 1971
Financing arrangements	Jan., 1972	Jan., 1972	Jan., 1972
Award contract for secondary works and/or phosphorus reduction	April, 1972	April, 1972	April, 1972
Initial contract for sewer separation	April, 1972	April, 1972	April, 1972
Secondary works completed and in operation	Nov., 1973	Nov., 1973	Jan., 1975
Tertiary works completed and in operation	Nov., 1973	Jan., 1975	Jan., 1975
Sewer separation projects completed	Nov., 1979	Nov., 1979	Nov., 1979

(1) Included only municipalities which discharge sewage directly to an interstate lake, bay or reservoir.

(2) Normally includes some sources not discharging directly to interstate waters but which because of proximity or inadequate treatment may violate standards for interstate waters.

(3) Except for possible discharge of nutrients.

MINNESOTA ADMINISTRATIVE RULES AND REGULATIONS

Rules, Regulations, Classifications and Water Standards

1969 SUPPLEMENT

Minn. Reg. WPC 15

Filed with the Secretary of State
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STATE OF MINNESOTA
POLLUTION CONTROL AGENCY

CHAPTER FIFTEEN: WPC 15

CRITERIA FOR THE CLASSIFICATION OF THE INTERSTATE WATERS OF THE STATE AND THE ESTABLISHMENT OF STANDARDS OF QUALITY AND PURITY

WPC 15 The official policy and purpose of the State of Minnesota in regard to these matters is set forth in the Minnesota Water Pollution Control Statutes:

Sec. 115.42. It is the policy of the state to provide for the prevention, control and abatement of pollution of all waters of the state, so far as feasible and practical, in furtherance of conservation of such waters and protection of the public health and in furtherance of the development of the economic welfare of the state . . . . It is the purpose of Laws 1963, Chapter 874, to safeguard the waters of the state from pollution by: (a) preventing any new pollution; and (b) abating pollution existing when Laws 1963, Chapter 874, become effective, under a program consistent with the declaration of policy above stated.

Sec. 115.44 Subd. 2. In order to attain the objectives of Laws 1963, Chapter 874, the commission* after proper study, and after conducting public hearing upon due notice, shall, as soon as practicable, group the designated waters of the state into classes and adopt classifications and standards of purity and quality therefor. Such classification shall be made in accordance with considerations of best usage in the interest of the public and with regard to the considerations mentioned in subdivision 3 hereof.

Sec. 115.44 Subd. 8. The commission* may classify waters and adopt criteria and standards in such form and based on such evidence as it may deem necessary and sufficient for the purposes of meeting requirements of such federal laws, notwithstanding any provisions in Chapter 115 or any other state law to the contrary . . . . Notwithstanding the provisions of subdivision 4, wherever advisable and practicable the commission* may establish standards for effluent of disposal systems entering waters regardless of whether such waters are or are not classified.

In accordance with this declaration of policy and legislative intent, and under the powers delegated to the Agency, the following interstate water use classifications and corresponding standards of quality and purity are hereby adopted by the Pollution Control Agency as provided by law.

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Executive Secretary and
Chief Executive Officer

Robert C. Tuveson, Chairman
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Dated: April 8, 1969

Homer C. Luick, Vice-Chairman

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*Laws of 1967, Chapter 882, abolished the Water Pollution Control Commission and transferred its powers and duties to the Minnesota Pollution Control Agency.

(a) **Introduction**

(1) **Definitions.** The terms "waters of the state" for the purposes of this regulation shall be construed to mean interstate waters as herein below defined, and the terms "sewage," "industrial wastes," and "other wastes," as well as any other terms for which definitions are given in the Water Pollution Control Statutes, as used herein have the meanings ascribed to them in Minnesota Statutes, Sections 115.01 and 115.41, with the exception that disposal systems or treatment works operated under permit of the Agency shall not be construed to be "waters of the state" as the term is used herein. The current requirements of applicable federal laws which must be met are set forth in the Federal Water Pollution Control Act, as amended (33 U.S.C. 466 et seq.). Interstate waters are defined in Section 13 (e) thereof as including all rivers, lakes, and other waters that flow across or form a part of state boundaries. Other terms and abbreviations used herein which are not specifically defined in the law shall be construed in conformance with the context, and in relation to the applicable section of the statutes pertaining to the matter at hand, and current professional usage.

(2) **Uses of the Interstate Waters.** The classifications are listed separately in accordance with the need for interstate water quality protection, considerations of best use in the interest of the public and other considerations, as indicated in Minnesota Statutes, Section 115.44. The classifications should not be construed to be an order of priority, nor considered to be exclusive or prohibitory of other beneficial uses unless so stated in regard to discharge or disposal of sewage, industrial wastes or other wastes commonly associated with such other uses, where such discharges may adversely affect the specified uses. Only the uses of the interstate waters of the state as a medium for disposal of sewage, industrial wastes or other wastes is subject to regulation by the Agency, not their appropriation or other use such as for navigation or recreation. Where more than one of the listed uses may occur without reasonable separation in distance on the same interstate waters, appropriate adjustments will be made in the classifications and standards to take into account such intermingling of uses.

(3) **Determination of Compliance.** In making tests or analyses of the interstate waters of the state, sewage, industrial wastes or other wastes to determine compliance with the standards, samples shall be collected in such manner and place, and of such type, number and frequency as may be considered satisfactory by the Agency from the viewpoint of adequately reflecting the condition of the interstate waters, the composition of the effluents, and the effects of the pollutants upon the specified uses. Reasonable allowance will be made for dilution of the effluents in relation to the uses of the interstate waters into which they are discharged or other interstate waters which may be affected. The samples shall be preserved and analyzed in accordance with procedures given in the 1965 edition of Standard Methods for the Examination of Water and Waste-Water, by the American Public Health Association, American Water Works Association, and the Water Pollution Control Federation, and any revisions or amendments thereto, or other methods acceptable to the Agency.

(4) **Natural Interstate Water Quality.** The interstate waters may, in a state of nature, have some characteristics or properties approaching or exceeding the limits specified in the standards. The standards shall be construed as limiting the addition of pollutants of human origin to those of natural origin, where such be present, so that in total the specified limiting concentrations will not be exceeded in the interstate waters by reason of such

controllable additions; except that where the background level of the natural origin is reasonably definable and normally is higher than the specified standard the natural level may be used as the standard for controlling the addition of pollutants of human origin which are comparable in nature and significance with those of natural origin, but where the natural background level is lower than the specified standard and where reasonable justification exists for preserving the quality of the interstate waters as nearly as possible to that found in a state of nature, the natural level may be used instead of the specified standard as the maximum limit on the addition of pollutants. In the adoption of standards for individual interstate waters, the Agency will be guided by the standards set forth herein but may make reasonable modifications of the same on the basis of evidence brought forth at a public hearing if it is shown to be desirable and in the public interest to do so in order to encourage the best use of the interstate waters or the lands bordering such interstate waters.

Waters which are of quality better than the established standards will be maintained at high quality unless a determination is made by the State that a change is justifiable as a result of necessary economic or social development and will not preclude appropriate beneficial present and future uses of the waters. Any project or development which would constitute a source of pollution to high quality waters will be required to provide the highest and best practicable treatment to maintain high water quality and keep water pollution at a minimum. In implementing this policy, the Secretary of the Interior will be provided with such information as he requires to discharge his responsibilities under the Federal Water Quality Act, as amended.

(5) **Variance from Standards.** In any case where, upon application of the responsible person or persons, the Agency finds that by reason of exceptional circumstances the strict enforcement of any provision of these standards would cause undue hardship; that disposal of the sewage, industrial waste or other waste is necessary for the public health, safety or welfare; and that strict conformity with the standards would be unreasonable, impractical or not feasible under the circumstances; the Agency in its discretion may permit a variance therefrom upon such conditions as it may prescribe for prevention, control or abatement of pollution in harmony with the general purposes of these classifications and standards and the intent of the applicable state and national laws. The Federal Water Pollution Control Administration will be advised of any permits which may be issued under this clause together with information as to the need therefor.

(b) **Water Use Classifications—All Interstate Waters of the State**

Based on considerations of best usage in the interest of the public and in conformance with the requirements of the applicable statutes, the interstate waters of the state shall be grouped into one or more of the following classes:

(1) **Domestic Consumption.** (to include all interstate waters which are or may be used as a source of supply for drinking, culinary or food processing use or other domestic purposes, and for which quality control is or may be necessary to protect the public health, safety or welfare.)

(2) **Fisheries and Recreation.** (to include all interstate waters which are or may be used for fishing, fish culture, bathing or any other recreational purposes, and for which quality control is or may be necessary to protect aquatic or terrestrial life, or the public health, safety or welfare.)

(3) **Industrial Consumption.** (to include all interstate waters which are or may be used as a source of supply for industrial process or cooling water, or any other industrial or commercial purposes, and for which quality control is or may be necessary to protect the public health, safety or welfare.)

(4) **Agriculture and Wildlife.** (to include all interstate waters which are or may be used for any agriculture purposes, including stock watering and irrigation, or by waterfowl or other wildlife, and for which quality control is or may be necessary to protect terrestrial life or the public health, safety or welfare.)

(5) **Navigation and Waste Disposal.** (to include all interstate waters which are or may be used for any form of water transportation or navigation, disposal of sewage, industrial waste or other waste effluents, or fire prevention, and for which quality control is or may be necessary to protect the public health, safety or welfare.)

(6) **Other Uses.** (to include interstate waters which are or may serve the above listed uses or any other beneficial uses not listed herein, including without limitation any such uses in this or any other state, province, or nation of any interstate waters flowing through or originating in this state, and for which quality control is or may be necessary for the above declared purposes, or to conform with the requirements of the legally constituted state or national agencies having jurisdiction over such interstate waters, or any other considerations the Agency may deem proper.)

(c) General Standards Applicable to All Interstate Waters of the State

(1) No untreated sewage shall be discharged into any interstate waters of the state. No treated sewage, or industrial waste or other wastes containing viable pathogenic organisms, shall be discharged into interstate waters of the state without effective disinfection. Effective disinfection of any discharges, including combined flows of sewage and storm water, will be required where necessary to protect the specified uses of the interstate waters.

(2) No raw or treated sewage, industrial waste or other wastes shall be discharged into any interstate waters of the state so as to cause any nuisance conditions, such as the presence of significant amounts of floating solids, scum, oil slicks, excessive suspended solids, material discoloration, obnoxious odors, gas ebullition, deleterious sludge deposits, undesirable slimes or fungus growths, or other offensive or harmful effects.

(3) Existing discharges of inadequately treated sewage, industrial waste or other wastes shall be abated, treated or controlled so as to comply with the applicable standards. Separation of sanitary sewage from natural run-off may be required where necessary to ensure continuous effective treatment of sewage.

(4) The highest possible levels of water quality, including dissolved oxygen, which are attainable in the interstate waters by continuous operation at their maximum capability of all units of treatment works discharging effluents into the interstate waters shall be maintained in the interstate waters in order to enhance conditions for the specified uses.

(5) Means for expediting mixing and dispersion of sewage, industrial waste, or other waste effluents in the receiving interstate waters shall be provided so far as practicable when deemed necessary by the Agency to maintain the quality of the receiving interstate waters in accordance with applicable standards.

(6) It is herein established that the Agency will require secondary treatment or the equivalent as a minimum for all municipal sewage and biodegradable, industrial or other wastes to meet the adopted water quality standards and a comparable high degree of treatment or its equivalent also will be required of all non-biodegradable industrial or other wastes unless the discharger can demonstrate to the Agency that a lesser degree of treatment or control will provide for water quality enhancement commensurate with present and proposed future water uses and a variance is granted under the provisions of the variance clause. Secondary treatment facilities are defined as works which will provide effective sedimentation, biochemical oxidation, and disinfection, or the equivalent, including effluents conforming to the following:

Substance or Characteristic	Limiting Concentration or Range
5-Day biochemical oxygen demand	25 milligrams per liter
Total coliform group organisms	1,000 MPN/100 ml
Total suspended solids	30 milligrams per liter
Oil	Essentially free of visible oil
Turbidity	25
pH range	6.5 - 8.5

(7) Allowance shall not be made in the design of treatment works for low stream flow augmentation unless such flow augmentation of minimum flow is dependable under applicable laws or regulations.

(8) In any instance where it is evident that natural mixing or dispersion of an effluent is not effective in preventing pollution, or that it may not be feasible to provide by other means for effective mixing or dispersion of an effluent, or if at the applicable stream flows mentioned in the sections on specific standards of interstate water quality and purity it is evident that the specified stream flow may be less than the effluent flow, the specific standards may be interpreted as effluent standards for control purposes, where applicable. The period of record for determining the specific flow for the stated recurrence interval, where records are available, will include at least the most recent 10 years of record, including flow records obtained after establishment of flow regulation devices, if any. Such calculations will not be applied to lakes and their embayments which have no comparable flow recurrence interval. Where stream flow records are not available, the flows may be estimated on the basis of available information on the watershed characteristics, precipitation, run-off and other pertinent data. In addition, the following effluent standards may be applied without any allowance for dilution where stream flow or other factors are such as to prevent adequate dilution, or where it is otherwise necessary to protect the interstate waters for the stated uses:

Item	Limits
5-day biochemical oxygen demand	20 milligrams per liter
Total phosphorus	1 milligram per liter
Total suspended solids	20 milligrams per liter

It is the intention of the Agency to require removal of nutrients from all sources to the fullest practicable extent wherever sources of nutrients are considered to be actually or potentially inimical to preservation or enhancement of the designated water uses.

(9) In any case where, after a public hearing, the Agency finds it necessary for conservation of the interstate waters of the state, or protection

of the public health, or in furtherance of the development of the economic welfare of the state, it may prohibit or further limit the discharge to any designated interstate waters of any sewage, industrial waste, or other waste effluents, or any component thereof, whether such effluents are treated or untreated, or existing or new, notwithstanding any other provisions of classifications or specific standards stated herein which may be applicable to such designated interstate waters.

(10) In any proceeding where specific standards have been adopted which are directly or indirectly applicable to named interstate waters of the state, it shall be incumbent upon all persons responsible for existing or new sources of sewage, industrial wastes or other wastes which are or will be discharged to such interstate waters, to treat or control their wastes so as to produce effluents having a common level or concentration of pollutants of comparable nature and effect as may be necessary to meet the specified standards or better, and in no case shall the concentration of polluting substances in any individual effluent be permitted to exceed the common concentration or level required of the other sources of comparable nature and effect discharging to the same classified and named interstate waters, regardless of differences in the amount of pollutional substances discharged, or degree of treatment involved.

(11) Liquid substances which are not commonly considered to be sewage or industrial wastes but which could constitute a pollution hazard shall be stored in accordance with Regulation WPC 4, and any revisions or amendments thereto. Other wastes as defined by law or other substances which could constitute a pollution hazard shall not be desposited in any manner such that the same may be likely to gain entry into any interstate waters of the state in excess of or contrary to any of the standards herein adopted, or cause pollution as defined by law.

(12) No sewage, industrial waste or other wastes shall be discharged into the interstate waters of the state in such quantity or in such manner alone or in combination with other substances as to cause pollution thereof as defined by law. In any case where the interstate waters of the state into which sewage, industrial wastes or other waste effluents discharge are assigned different standards than the interstate waters into which such receiving interstate waters flow, the standards applicable to the interstate waters into which such sewage, industrial waste or other wastes discharged shall be supplemented by the following:

The quality of any waters of the state receiving sewage, industrial waste or other waste effluents shall be such that no violation of the standards of any interstate waters of the state in any other class shall occur by reason of the discharge of such sewage, industrial waste or other waste effluents.

(13) Questions concerning the permissible levels, or changes in the same, of a substance, or combination of substances, of undefined toxicity to fish or other biota shall be resolved in accordance with the methods specified by the National Technical Advisory Committee of the Federal Water Pollution Control Administration, U. S. Department of the Interior. The Committee's recommendations also will be used as official guidelines in other aspects where the recommendations may be applicable.

(14) All persons operating or responsible for sewage, industrial waste or other waste disposal systems which are adjacent to or which discharge effluents to these waters or to tributaries which affect the same, shall submit

regularly every month a report to the Agency on the operation of the disposal system, the effluent flow, and the characteristics of the effluents and receiving waters. Sufficient data on measurements, observations, sampling and analyses, and other pertinent information shall be furnished as may be required by the Agency to in its judgment adequately reflect the condition of the disposal system, the effluent, and the waters receiving or affected by the effluent.

(d) **Specific Standards of Quality and Purity for Designated Classes of Interstate Waters of the State.** The following standards shall prescribe the qualities or properties of the interstate waters of the state which are necessary for the designated public use or benefit and which, if the limiting conditions given are exceeded, shall be considered indicative of a polluted condition which is actually or potentially deleterious, harmful, detrimental or injurious with respect to such designated uses or established classes of the interstate waters:

(1) Domestic Consumption

Class A The quality of this class of the interstate waters of the state shall be such that without treatment of any kind the raw waters will meet in all respects both the mandatory and recommended requirements of the Public Health Service Drinking Water Standards—1962 for drinking water as specified in Publication No. 956 published by the Public Health Service of the U. S. Department of Health, Education and Welfare, and any revisions, amendments or supplements thereto. This standard will ordinarily be restricted to underground waters with a high degree of natural protection. The basic requirements are given below:

Substance or Characteristic	Limit or Range
Total coliform organisms	1 most probable number per 100 mililiters
Turbidity value	5
Color value	15
Threshold odor number	3
Methylene blue active substance (MBAS)	0.5 milligram per liter
Arsenic (As)	0.01 milligram per liter
Chlorides (Cl)	250 milligrams per liter
Copper (Cu)	1 milligram per liter
Carbon Chloroform extract	0.2 milligram per liter
Cyanides (CN)	0.01 milligram per liter
Fluorides (F)	1.5 milligrams per liter
Iron (Fe)	0.3 milligram per liter
Manganese (Mn)	0.05 milligram per liter
Nitrates (NO_3)	45 milligrams per liter
Phenol	0.001 milligram per liter
Sulfates (SO_4)	250 milligrams per liter
Total dissolved solids	500 milligrams per liter
Zinc (Zn)	5 milligrams per liter
Barium (Ba)	1 milligram per liter
Cadmium (Cd)	0.01 milligram per liter
Chromium (Hexavalent, Cr)	0.05 milligram per liter
Lead (Pb)	0.05 milligram per liter
Selenium (Se)	0.01 milligram per liter
Silver (Ag)	0.05 milligram per liter

Class B The quality of this class of the interstate waters of the state shall be such that with approved disinfection, such as simple chlorination or its equivalent, the treated water will meet in all respects both the mandatory and recommended requirements of the Public Health Service Drinking Water Standards—1962 for drinking water as specified in Publication No. 956 published by the Public Health Service of the U. S. Department of Health, Education and Welfare, and any revisions, amendments or supplements thereto. This standard will ordinarily be restricted to surface and underground waters with a moderately high degree of natural protection. The physical and chemical standards quoted above for Class A interstate waters shall also apply to these interstate waters in the untreated state, except as listed below:

Substance or Characteristic	Limit or Range
Total coliform organisms	50 most probable number per 100 milliliters

Class C The quality of this class of the interstate waters of the state shall be such that with treatment consisting of coagulation, sedimentation, filtration, storage and chlorination, or other equivalent treatment processes, the treated water will meet in all respects both the mandatory and recommended requirements of the Public Health Service Drinking Water Standards—1962 for drinking water as specified in Publication No. 956 published by the Public Health Service of the U. S. Department of Health, Education and Welfare, and any revisions, amendments or supplements thereto. This standard will ordinarily be restricted to surface waters, and ground waters in aquifers not considered to afford adequate protection against contamination from surface or other sources of pollution. Such aquifers normally would include fractured and channeled limestone, unprotected impervious hard rock where interstate water is obtained from mechanical fractures, joints, etc., with surface connections, and coarse gravels subjected to surface water infiltration. The physical and chemical standards quoted above for Class A interstate waters shall also apply to these interstate waters in the untreated state, except as listed below:

Substance or Characteristic	Limit or Range
Total coliform organisms	4,000 most probable number per 100 milliliters
Turbidity value	25

Class D The quality of this class of the interstate waters of the state shall be such that after treatment consisting of coagulation, sedimentation, filtration, storage and chlorination, plus additional pre, post, or intermediate stages of treatment, or other equivalent treatment processes, the treated water will meet in all respects the recommended requirements of the Public Health Service Drinking Water Standards—1962 for drinking water as specified in Publication No. 956 published by the Public Health Service of the U. S. Department of Health, Education and Welfare, and any revisions, amendments or supplements thereto. This standard will ordinarily be restricted to surface waters, and ground waters in aquifers not considered to afford adequate protection against contamination from surface or other sources of pollution. Such aquifers normally would include fractured and channeled limestone, unprotected impervious hard rock where water is obtained from mechanical fractures, joints, etc., with surface connections, and coarse gravels subjected to surface water infiltration.

The concentrations or ranges given below shall not be exceeded in the raw waters before treatment:

Substance or Characteristic	**Limit or Range**
Total coliform organisms	4,000 most probable number per 100 milliliters
Arsenic (As)	0.05 milligram per liter
Barium (Ba)	1 milligram per liter
Cadmium (Cd)	0.01 milligram per liter
Chromium (Cr + 6)	0.05 milligram per liter
Cyanide (CN)	0.2 milligram per liter
Fluoride (F)	1.5 milligrams per liter
Lead (Pb)	0.05 milligram per liter
Selenium (Se)	0.01 milligram per liter
Silver (Ag)	0.05 milligram per liter

In addition to the above listed standards, no sewage, industrial waste or other wastes, treated or untreated, shall be discharged into or permitted by any person to gain access to any interstate waters classified for domestic consumption so as to cause any material undesirable increase in the taste, hardness, temperature, toxicity, corrosiveness or nutrient content, or in any other manner to impair the natural quality or value of the interstate waters for use as a source of drinking water.

(2) **Fisheries and Recreation**

Class A The quality of this class of the interstate waters of the state shall be such as to permit the propagation and maintenance of warm or cold water sport or commercial fishes and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. Limiting concentrations or ranges of substances or characteristics which should not be exceeded in the interstate waters are given below:

Substance or Characteristic	**Limit or Range**
Dissolved oxygen	Not less than 7 milligrams per liter from October 1st and continuing through May 31st, and Not less than 5 milligrams per liter at other times
Temperature	No material increase
Ammonia (N)	Not to exceed a trace
Chlorides (Cl)	50 milligrams per liter
Chromium (Cr)	Not to exceed a trace
Copper (Cu)	Not to exceed a trace
Cyanides (CN)	Not to exceed a trace
Oil	Not to exceed a trace
pH value	6.5 - 8.5
Phenols	Not to exceed a trace
Turbidity value	10
Color value	30
Total coliform organisms	1,000 most probable number per 100 milliliters
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

Discharges of sewage, industrial waste or other waste effluents shall be controlled so that the standards will be maintained at all stream flows which are equal to or exceeded by 90 percent of the seven consecutive daily average flows of record (the lowest weekly flow with a once in ten year recurrence interval) for the critical month(s).

Class B The quality of this class of the interstate waters of the state shall be such as to permit the propagation and maintenance of sport or commercial fishes and be suitable for aquatic recreation of all kinds, including bathing, for which the waters may be usable. Limiting concentrations or ranges of substances or characteristics which should not be exceeded in the interstate waters are given below:

Substance or Characteristic	**Limit or Range**	
Dissolved oxygen	Not less than 6 milligrams per liter from April 1 through May 31, and Not less than 5 milligrams per liter at other times.	
Temperature	86° F in July and August, 80° F in June and September, 67° F in May and October, 55° F in April and November, 43° F in March and December, and 37° F in Jan. and February.	Or 5° F above ambient, whichever is greater, except that in no case shall it exceed 90° F.
Ammonia (N)	1 milligram per liter	
Chromium (Cr)	0.05 milligram per liter	
Copper (Cu)	0.2 milligram per liter	
Cyanides (CN)	0.02 milligram per liter	
Oil	Not to exceed a trace	
pH Value	6.5 - 9.0	
Phenols	0.01 milligram per liter	
Turbidity value	25	
Total coliform organisms	1,000 most probable number per 100 milliliters	
Radioactive materials	Not to exceed the lowest concentration permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.	

Discharges of sewage, industrial waste or other waste effluents shall be controlled so that the standards will be maintained at all stream flows which are equal to or exceeded by 90 percent of the 7 consecutive daily average flows of record (the lowest weekly flow with a once in 10 year recurrence interval) for the critical month.

Class C The quality of this class of the interstate waters of the state shall be such as to permit the propagation and maintenance of fish of species, commonly inhabiting waters of the vicinity under natural conditions, and be suitable for boating and other forms of aquatic recreation not involving prolonged intimate contact with the water for which the interstate waters may be usable. Limiting concentrations or ranges of substances or characteristics which should not be exceeded in the interstate waters are given below:

Substance or Characteristic	Limit or Range
Dissolved oxygen	Not less than 5 milligrams per liter from April 1 through May 31, and Not less than 3 milligrams per liter at other times.
Temperature	90° F in July and August, 87° F in June and September, 75° F in May and October, 63° F in April and November, 51° F in March and December and 45° F in January and Feb. Or 5° F above ambient, whichever is greater, except that in no case shall it exceed 90° F.
Ammonia	2 milligrams per liter
Chromium (Cr)	0.05 milligram per liter
Copper (Cu)	0.2 milligram per liter
Cyanides (CN)	0.02 milligram per liter
Oil	None in such quantities as to (1) produce a visible color film on the surface, (2) impart an oil odor to water or an oil taste to fish and edible invertebrates, (3) coat the banks and bottom of the watercourse or taint any of the associated biota, or (4) become effective toxicants according to the criteria recommended.
pH value	6.0 - 9.5
Phenols	None that could impart odor or taste to fish flesh or other fresh-water edible products such as crayfish, clams, prawns and like creatures. Where it seems probable that a discharge may result in tainting of edible aquatic products, bioassasys and taste panels will be required to determine whether tainting is likely.
Turbidity value	25
Total coliform organisms	5,000 most probable number per 100 milliliters
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

Discharges of sewage, industrial waste or other waste effluents shall be controlled so that the standards will be maintained at all stream flows which are equal to or exceeded by 90 percent of the 7 consecutive daily average flows of record (the lowest weekly flow with a once in 10 year recurrence interval) for the critical month.

The aquatic habitat, which includes the interstate waters and stream bed, shall not be degraded in any material manner, there shall be no material increase in undesirable slime growths or aquatic plants, including algae, nor shall there be any significant increase in harmful pesticide or other residues in the waters, sediments and aquatic flora and fauna; the normal fishery and lower aquatic biota upon which it is dependent and the use thereof shall not be seriously impaired or endangered, the species composition shall not be altered materially, and the propagation or migration of the fish and other biota normally present shall not be prevented or hindered by the discharge of any sewage, industrial waste or other waste effluents to the interstate waters.

No sewage, industrial waste or other wastes shall be discharged into any of the interstate waters of this category so as to cause any material change in any other substances or characteristics which may impair the quality of the interstate waters or the aquatic biota of any of the above-listed classes or in any manner render them unsuitable or objectionable for fishing, fish culture or recreational uses. Additional selective limits or changes in the discharge bases may be imposed on the basis of local needs.

(3) **Industrial Consumption**

Class A The quality of this class of the interstate waters of the state shall be such as to permit their use without chemical treatment, except softening for ground water, for most industrial purposes, except food processing and related uses, for which a high quality of water is required. The quality shall be generally comparable to Class B waters for domestic consumption, except for the following:

Substance or Characteristics	Permissible Limit or Range	
Chlorides (Cl)	50 milligrams per liter	
Hardness	50 milligrams per liter	
pH value	6.5 - 8.5	
Temperature	75° F in July and August, 70° F in June and September, 60° F in May and October, 50° F in April and November, 40° F in March and December, and 35° F in January and February.	(Surface)
	55° F	(Ground)
Total coliform organisms	5,000 most probable number per 100 milliliters	

Class B The quality of this class of the interstate waters of the state shall be such as to permit their use for general industrial purposes, except food processing, with only a moderate degree of treatment. The quality shall be generally comparable to Class D interstate waters used for domestic consumption, except for the following:

Substance or Characteristic	Permissible Limit or Range
Chlorides (Cl)	100 milligrams per liter
Hardness	250 milligrams per liter (Surface) 350 milligrams per liter (Ground)
pH value	6.0 - 9.0
Temperature	65° F (ground) 86° F (surface)
Total coliform organisms	5,000 most probable number per 100 milliliters

Class C The quality of this class of the interstate waters of the state shall be such as to permit their use for industrial cooling and materials transport without a high degree of treatment being necessary to avoid severe fouling, corrosion, scaling, or other unsatisfactory conditions. The following shall not be exceeded in the interstate waters:

Substance or Characteristic	**Limit or Range**
Chlorides (Cl)	250 milligrams per liter
Hardness	500 milligrams per liter
pH value	6.0 - 9.5
Temperature	65° F (ground) 90° F (surface)
Total coliform organisms	5,000 most probable number per 100 milliliters

Additional selective limits may be imposed for any specific interstate waters as needed.

(4) **Agriculture and Wildlife**

Class A The quality of this class of the interstate waters of the state shall be such as to permit their use for irrigation without significant damage or adverse effects upon any crops or vegetation usually grown in the area, including truck garden crops. The following concentrations or limits shall be used as a guide in determining the suitability of the waters for such uses, together with the recommendations contained in Handbook 60 published by the Salinity Laboratory of the U. S. Department of Agriculture, and any revisions, amendments or supplements thereto:

Substance or Characteristic	**Permissible Limit or Range**
Bicarbonates (HCO_3)	5 milliequivalents per liter
Boron (B)	0.5 milligram per liter
pH value	5.0 - 8.5
Specific conductance	1,000 micromhos per centimeter
Total dissolved salts	700 milligrams per liter
Sodium (Na)	60% of total cations as milliquivalents per liter
Total coliform organisms	5,000 most probable number per 100 milliliters
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.

Class B The quality of this class of the interstate waters of the state shall be such as to permit their use by livestock and wildlife without inhibition or injurious effects. The limits or concentrations of substances or characteristics given below shall not be exceeded in the interstate waters:

Substance or Characteristic	**Limit or Range**
pH value	6.0 - 9.5
Total salinity	1,000 milligrams per liter
Total coliform organisms	5,000 most probable number per 100 milliliters
Radioactive materials	Not to exceed the lowest concentrations permitted to be discharged to an uncontrolled environment as prescribed by the appropriate authority having control over their use.
Unspecified toxic substances	None at levels harmful either directly or indirectly.

Additional selective limits may be imposed for any specific interstate waters as needed.

(5) **Navigation and Waste Disposal.** The quality of this class of the interstate waters of the state shall be such as to be suitable for esthetic enjoyment or scenery and to avoid any interference with navigation or damaging effects on property. The following limits or concentrations shall not be exceeded in the interstate waters:

Substance or Characteristics	**Limit or Range**
Total coliform organisms	5,000 most probable number per 100 milliliters
pH value	5.5 - 10.0
Hydrogen sulfide	Not to exceed a trace

Additional selective limits may be imposed for any specific interstate waters as needed.

(6) **Other Uses.** The uses to be protected in this class may be under other jurisdictions and in other areas to which the interstate waters of the state are tributary, and may include any or all of the uses listed in the foregoing categories, plus any other possible beneficial uses. The Agency therefore reserves the right to impose any standards necessary for the protection of this class, consistent with legal limitations.

MR. STEIN: Before we open this to comments or questions, may I say that sometimes when you make statements, even though the people up here feel they have the professional expertise, I notice sometimes you feel that your full statements are not taken into account. I want to assure you that we listen to them all.

Now, Mrs. Harvell, wherever you are, on our left or otherwise, I would like to call to your attention that the Abex Corporation is listed in this list as an industrial waste source that is not in compliance.

Any comments or questions?

MR. BADALICH: Thank you. Mr. Chairman, if I may, I would like to call upon--

MR. STEIN: Wait. Wait. Don't rush off.

MR. BADALICH: Oh.

(Laughter.)

MR. STEIN: I want to give them a fair chance.

John, if you would go back, most of my questions are for clarification or explanatory purposes.

Your No. 7. When do you expect to have an agreement with Pickands Mather? Do you have a date in mind?

MR. BADALICH: Yes, we do. Mr. Chairman, if you will bear with me, I believe I have a letter to that effect which I just received a day or so ago.

MR. STEIN: All right.

MR. BADALICH: Mr. Chairman, this was a letter I received on August 7, actually I received it in my office on August 10. It is addressed to me. It says:

> "This will acknowledge your notice of July 24 requesting our appearance at the Lake Superior enforcement conference called for August 12 and 13 and would also confirm the results of our meeting with your Agency held on August 5 in St. Paul.
>
> "The two facilities in question have been:
>
> "No. 1, the sewage disposal facilities at our plant site at White Lakes; and
>
> "No. 2, the sewage disposal facilities at our taconite homestead area on Lake Superior.
>
> "At the meeting held with your Agency on August 5 after we submitted test data from our consulting firm of Ruble and Kaple, in Duluth, the Agency acknowledged that at our White Lakes facility we are in substantial compliance

with all standards and regulations, including the phosphorus limits set by the Agency on July 13, 1970.

"At the meeting we also submitted preliminary plans for some alteration to our facility at Taconite Harbor. The facility has an effluent of only approximately five gallons per minute and we are considering making some slight change in the facility as indicated by the plans submitted to the Agency on the 5th.

"In view of the above, we have been advised by the Agency that there is no need for us to appear at the conference on the 12th and 13th. Accordingly, we make no request for our appearance to be heard at the conference."

This is signed by Pickands Mather & Company, by Mr. Manthey, Director of Public Affairs.

MR. STEIN: O.K., if they only have five gallons, why can't they stop that almost immediately?

MR. BADALICH: Yes. I believe they met with the staff, and in turn I believe this will either be taken care of by a separate system or they will try to get it into the city sewer system or soil absorption system, one of the three alternatives that we--

MR. STEIN: Yes. What I am talking about is a date. And again this isn't in the sense of argument or anything, but I think when we have a small source like that there is no reason why we can't get that off the record.

MR. BADALICH: I think we can, Mr. Chairman. And if I remember correctly the meeting and in consultation with the staff, I believe that this will probably even be accomplished this construction season.

MR. STEIN: Good.

The next point I want to bring up is we have got a report here and the report isn't changed from previous conferences, and in this matter, as always, we have had complete candor and full disclosure from Minnesota. We don't seem to be making much progress with Superwood.

MR. BADALICH: Well, I think it is pretty well stated in my report here, Mr. Chairman, that we have tried to arrive at a stipulation with the corporation to agree and to adhere to our effluent requirements of our interstate water quality standards WPC 15. The negotiations bogged down and it was on April 13 of this year at an

Agency meeting that the Agency authorized me to either enter into a stipulation within, I think it was, 10 or so days or to certify this to the Attorney General.

Well, after negotiations from April until I believe it was the latter part of June or first of July, this was certified to the Attorney General's office for litigation, and presently this matter is being reviewed by the Hennepin County District Court. And as a matter of information I just finished several days of deposition on this matter and the court trial will be continuing here probably within a month or so.

MR. STEIN: Superwood, as far as you know, is not going to be here today, are they?

MR. BADALICH: No, they will not. I do have a letter from them indicating that they will not make an appearance and the problem will be resolved through the courts.

MR. STEIN: Well, I tell you, of course we have two sets of courts in this country, Federal and State courts. From what I have been hearing about Superwood, I think we have to investigate and see whether they are violating a Federal water quality standard--a Federal standard as well as a State standard, and--

MR. BADALICH: Well, I think they are, because--

MR. STEIN: I am going to ask Mr. Mayo to send us in a report. If they are, I am going to recommend that we proceed with a 180-day notice, and if this recommendation is accepted by the Secretary, these fellows, if they don't get along with the State, will be faced with a Federal court action. I think it is up to them and you might advise them that.

MR. BADALICH: Mr. Chairman, if I may ask, what is the useful purpose of this 180-day action? I believe under the Federal law it certainly gives the major responsibility for abatement of any discharge or any pollutant in the State to be handled primarily by the States, and I believe that the schedule that will be worked out with Superwood, whether it is through litigation or through stipulation, will still be within the compliance schedule or the outside compliance date of this conference or interstate water quality standards.

MR. STEIN: I understand that. But, sir, I tell you, we have a statutory obligation too. I have not seen any indication in any report that Superwood is coming forth with any plan that they made any view to deal with the State Agency, and we have been meeting at this conference time after time and we just have to do that.

I am glad to have the State court run its course, and I hope you can resolve it through that or through other means. But as far as I can see, unless I am wrong on this--and we will have to get a report from Mr. Mayo from the region--but if the facts that are stated here are correct and Superwood hasn't seen fit to contradict them, they well may be in violation of Federal law. If they are in violation of Federal law, as a Federal official charged with carrying out that law, I am obliged to bring an action under that law.

MR. BADALICH: All right, that is true, Mr. Stein. But then again it indicates that the State is doing nothing towards making a discharger come within compliance, and I certainly think we are. In fact--

MR. STEIN: I did not say you weren't.

MR. BADALICH: Well--

MR. STEIN: I think you have made every effort with Superwood. And as a matter of fact, I would like to commend your effort and your forbearance. But the point is I think these people just have to comply.

MR. BADALICH: Well, I agree with you there and I think they are. Even during the course of our negotiations on the stipulation, it was agreed upon and the company has hired a consulting engineer and the consulting engineer right now is working on a time schedule that was proposed by our Agency, but the fact of the matter, where we got into a hangup is the fact that we couldn't get them to agree specifically to our effluent requirement.

And in conjunction with this, I would like to read this letter from the counsel representing Superwood Corporation into the record. It indicates that even though we are in the present litigation, they are still working towards a compliance and trying to reach a satisfactory solution to their problem.

This is addressed to me again. It is referred to the State of Minnesota versus Superwood Corporation action.

> "In response to your letter of July 23, 1970, which was received on July 30, 1970, by Mr. M. J. Opsahl"--

This letter indicated to all the dischargers that the conference was being held and we in turn felt that they should make themselves known at the conference and in turn present their particular individual case.

--"President of Superwood Corporation regarding the reconvening of the Lake Superior enforcement conference on August 12, I am replying as attorney for the company, which will have no representative at the conference.

"As you know, Roy F. Weston, environmental scientists and engineers, have been working for Superwood since last May and in that capacity submitted a schedule with a letter to you dated June 29, 1970."

And this letter and the schedule was a part of the stipulation, but as indicated, because of not the strict adherence to the effluent requirement, this was not accepted by the Agency and in turn it was sent on to litigation.

"In addition, continued disinfection is now being provided for effluents containing pathogenic organisms. It is my understanding that Recommendation No. 9, page 50, of the April 1969, Revised 1970, Lake Superior Basin Report is the basis for the work of the Westin Consulting Engineers, whose report, expected on October 1, 1970, will be submitted to you.

"I believe the plans of the company

are thus within the schedule set by the conferees.

"Very truly yours, William J. Hempel."

MR. STEIN: Well, we will have to examine that.

MR. BADALICH: I wish you would, Mr. Chairman.

MR. STEIN: Sure. As a general rule, though, Mr. Badalich, I think our polluted waters in this country are fringed with companies and municipalities who are working on the problem.

(Laughter.)

MR. BADALICH: Sure. But if you are getting compliance, Mr. Chairman, and according to a set compliance schedule, I think that is very well towards the program of abatement.

MR. STEIN: Right.

Now, the other problem I have--this is an information question only--you said U. S. Steel has furnished plans and indicated that chlorination facilities will provide for one outfall late this year. How many outfalls do they need chlorination for and when will they provide it?

MR. BADALICH: Normally they need outfall for--I should say chlorination for two outfalls. In this particular case, the reason this was stated, that they will chlorinate one outfall. The other outfall, I understand, these have been reviewed by our staff on preliminary plans, that they will be rerouting their sewage within the in-plant facilities and in turn be going through this one outfall, so that the second outfall will then not be required.

MR. STEIN: Will this be taken care of by the end of this year when the chlorination facilities are in or will this take longer?

MR. BADALICH: This will be completed by December of this year.

MR. STEIN: In other words, when the chlorination facilities come in, there will be no material coming out from the U. S. Steel plant that you believe needs chlorination which is not being chlorinated?

MR. BADALICH: That is correct.

MR. STEIN: Right. Thank you. One more.

Let's go on to your 4. You reported the Agency reported that a grant application had been prepared to study certain aspects of taconite tailings discharges.

Do you recall, Mr. Badalich, how much of a grant you asked for to study this?

MR. BADALICH: Yes, Mr. Chairman. I believe this is the monies that were allocated to the five States on the Upper Great Lakes in conjunction with the five-State pesticide program. At the time, I believe, at the opening of this conference, when Assistant Secretary of the Interior Klein was here, Governor Levander requested that in effect the Agency has already instituted many and completed many studies on pesticides in Lake Superior, that we would appreciate having some of this money diverted over towards a taconite study.

MR. STEIN: Yes. How much did you ask for?

MR. BADALICH: Thus far we have allocated $16,000 of the Federal $40,000 for the pesticide study and the remaining $24,000 we intended to go into more detailed studies on the effects of taconite tailings.

MR. STEIN: In other words, you are asking for about $24,000 for taconite tailings?

MR. BADALICH: Yes, this is what we originally had under the grant application.

MR. STEIN: You know what I am amazed at--that at the first session of the conference we had testimony from representatives of Reserve Mining saying they spent about $300,000 on their experts to come here and tell us why this shouldn't be done, and here you are asking for $24,000. If we put this money in to do a control program, I am not so sure that we would not be in better shape than just fighting this.

MR. BADALICH: That is exactly what we are stating here, Mr. Stein. In view of the fact that Reserve did have their reports, and in view of the fact that Dr. Mount and his staff at the National Water Quality Laboratory has presented many reports regarding the effects of taconite tailings, and so on, we felt that this would be repetition and this money could be used elsewhere. What we are asking at this time is probably maybe some direction from the conferees on what might be advisable, but as I stated earlier, that we will possibly use this money towards maybe studying the mercury pollution problems and maybe going into the algal and bacterial effects on the lake, and so on.

I am just stating that at this point we felt it wouldn't be necessary to spend this money for this particular study.

MR. STEIN: Right.

Are there any other comments or questions?

If not, thank you very much, Mr. Badalich, for a very excellent report.

MR. BADALICH: Thank you, sir.

MR. STEIN: Do you want to call on some other people?

MR. BADALICH: Yes, Mr. Chairman, I would like to call upon Mr. Lane Friedell, the Special Assistant Attorney General, who will give us a sort of resume of the court trial now pending in Two Harbors, Minnesota, regarding the Reserve matter.

Mr. Friedell.

LANE FRIEDELL

ASSISTANT ATTORNEY GENERAL

STATE OF MINNESOTA

MR. FRIEDELL: Thank you, John. Mr. Chairman.

My name is Lane Friedell. I am Assistant Attorney General for the State of Minnesota and I have been one of the two counsel employed by the Attorney General to handle the Reserve Mining vs. PCA lawsuit which has been in Lake County court for the last seven weeks.

The Attorney General of the State of Minnesota has not been a participant or given any testimony at any of the conferences prior to this. Quite obviously we have become very deeply involved into the question of pollution of Lake Superior, more specifically very deeply involved in the question of pollution of Lake Superior, alleged pollution by Reserve Mining Company.

Before I go into what I would like to say about this lawsuit and the position of the Attorney General, I would like to call upon Dr. Glenn Berryman to elicit information for the conference to consider concerning the economic feasibility of alternative methods of disposal that have been proposed by Reserve Mining Company for the disposal of their taconite tailings wastes.

The subject matter has previously been discussed at this conference early this morning and it is the Attorney General's opinion that this is a matter which should be dealt with by the person involved firsthand. As a consequence, we have decided to ask Dr. Glenn Berryman, of the University of Minnesota, who is now on leave to Touche Ross accounting firm, to present the factual matters that are on evidence in the Reserve Mining case in Two Harbors, Minnesota.

With that, if Dr. Berryman will come forward.

DR. GLENN BERRYMAN
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

DR. BERRYMAN: Mr. Stein, conferees, ladies and gentlemen.

In mid-July the Pollution Control Agency, State of Minnesota, asked that I take a look at some of the economic aspects of Reserve Mining's operation at Silver Bay, Minnesota, with particular emphasis on the economic aspects of adding pollution control facilities that would be related to the removal of the tailings disposal program and transporting those tailings elsewhere. I did make a limited review. Time did not permit a detailed review of all economic aspects.

Included in my review were a substantial number of documents and a substantial number of queries to corporate personnel. The documents included a return on investment schedules that had been prepared by Reserve Mining for the 1967-1969 years.

In addition, there was an engineering task force report that I reviewed, which has previously been alluded to by Mr. Badalich.

In addition, I looked at audited financial statements for the three years ended December 31, 1969, for Reserve Mining Company.

Also I reviewed various contracts between Reserve Mining, Armco Steel Corporation, Republic Steel Corporation.

Further I looked at the private ruling which was obtained by Reserve Mining from the Internal Revenue Service in connection with its basic operations.

Also Revenue Ruling 56, page 542, issued in 1956 by the Internal Revenue Service, as a guide to certain types of companies, of which Reserve is one, was reviewed.

With respect to the second types of items that I mentioned earlier, I queried company officials with respect to the figures which they had placed on their work papers on return on investment. I reviewed underlying worksheets which they exhibited to me and also worked with some of the documentary evidence which the company has created or which it has obtained in connection with its regular operations.

My review of these documents and the responses that I got to my queries disclosed to me the following facts with respect to the position of the Reserve Mining Company:

First, Reserve Mining is owned in equal parts by Armco Steel and Republic Steel.

Second, the level of operations of Reserve Mining is dictated by Armco and Republic Steel Company.

Third, debts of Reserve Mining are guaranteed by Armco and Republic Steel.

Fourth, the equitable ownership in the facilities of Reserve is in Republic and Armco Steel, and this is evidenced by some of the agreements which I did review.

Next, Reserve operates as a cost company for Federal income tax purposes. This means that the costs of operations incurred by Reserve Mining are borne in fact by Republic and Armco Steel. Those latter two companies reimburse Reserve Mining for the costs incurred in connection with its operations. They agree to provide essential funds for debt retirement. To the extent that current operations do not require immediate outlays, they are not required to reimburse Reserve in full for such items. For Federal income tax purposes this means that these costs are deducted on the tax returns of the two parent companies, Armco and Republic, and that the parent company is entitled to any percentage depletion deductions which would be available under the Internal Revenue Code.

Those findings in summary mean in effect that Reserve Mining is a part of, economically, Armco and Republic Steel Companies as a cost company. It is not a free-standing company and as such it does not have revenues in the usual sense of the term.

In order to get at economic feasibility, it is essential to make certain assumptions which would, in effect, place the company on a free-standing basis. These assumptions that I have made and which the Reserve officials made in connection with their calculations essentially are as follows. These assumptions you must keep in mind as we go through some of the figures in a few moments relating to the Reserve Mining operations.

First assumption: Shipments of ore are made at published market prices. You can recognize that the company is shipping in effect at cost and so this is not in accordance with the current realities. However, in order to get at economic feasibility we must make an assumption as to a price that would be obtained in the economic marketplace.

The second assumption: Costs, prices and production volumes are going to remain roughly at the 1967-1969 average levels.

Now some assumptions with respect to the pollution control facilities that might be added.

I referred earlier to an engineering progress report, and there were 19 alternative proposals contained in that. One of these proposals appeared to me to satisfy Pollution Control Agency standards and it involved the transport of tailings from the Reserve facility back to the general area of the mine. This is known as Proposal No. 2 and I will refer to it hereafter as that. This is a relatively expensive proposal, next to the most expensive in the engineering task force previously referred to. It involved capital costs of approximately $74 million and annual operating costs, including interest on borrowings and depreciation of facilities, in the amount of approximately $12.5 million. These figures were contained within that progress report and I have accepted those without further verification.

An additional assumption that was made is that the full capital cost would be borrowed and that the principal would be repaid over a 20-year period. Further, the average life of the facilities was assumed to be 20 years.

Final assumption: Federal income tax rate was assumed to be 22 percent on the first $25 thousand of taxable income and 48 percent with respect to item amounts of income in excess of that $25 thousand figure.

Now let's look at a few of the specific operating statistics.

The company's schedule indicated that average profit per ton for the three years ended December 31, 1969, amounted to $1.58. If we compare that profit with the selling price of the ore, this would show a 12.1 percent return on sales and this is after taxes, a fairly substantial figure by most standards. If we compare that profit as a percentage of sales with that of one of the controlling companies, namely Republic, for their 3-year period ended December 31, 1969, it was 5.6 percent.

You will recall we made some assumptions with respect to possible installation of pollution control facilities. If those facilities, at the cost previously stated, had been installed as of January 1, 1967, or thereabouts, we would, on a pro forma basis, expect the profit per ton would have been approximately 63 cents, a considerable decline, to be sure, but still as a percentage of sales we would have had close to a 5 percent rate.

Let's look at an alternate approach to getting at profitability, and this would be looking at a rate of return on total assets. They were approximately 7 percent for the three years ended December 31, 1969. This is taking the company's profit figure determined on the basis of the assumptions previously stated and comparing it to total assets as noted on the audited financial statements which I referred to at the beginning.

Let's take still another approach to the rate of return question. As all of you know, it is essential for a company to have funds available for operation. The funds provided by Reserve Mining--I am sorry--by Armco and Republic Steel, less amounts that have not been paid by those companies to the company for products, constitute what I am terming net funds provided by participants. Again using the company's book profits and dividing that by this net funds provided by participants, we come up with a figure of approximately 49 percent as the rate of return for that same 3-year period. Assuming that pollution control facilities had been installed, an equivalent figure would have been just under 20 percent.

Dr. G. Berryman

Let's take still another look at the well-being of the firm and this is to work on the basis of funds which would be available. This concept involves a determination of revenues at a published market price basis and deducting therefrom those costs and expenses which require current outlays and any outlays needed for debt reduction purposes. On this basis we would have had funds available for the three years ended 12-31-69 of $2.19 per ton, or assuming that the pollution control facilities had been added as of about the 1st of January 1967, the figure would have been about $1.17 per ton.

Let's forecast for just a moment. Funds available in the first five years after installation of pollution control facilities, assuming that the Tax Reform Act of 1969 signed by President Nixon at the end of December of last year were in effect, the company would have funds available of approximately $66 million; for the succeeding 15 years, or the life of those facilities, funds available would have been approximately $165 million; or a total for the 20-year period of about $231 million. You must recognize, however, that in these figures there is no provision made for adding to plant capacity or making major improvements with respect to them. However, it does provide for payment in full of the pollution control facilities.

Let's move to still a third way of looking at this possible installation of pollution control facilities. One possibility is that the company would choose to cease operations. I made a very limited study with respect to some of the costs that would be incurred here. Assuming that such shutdown were to take place on or about the end of December 1971, bonds outstanding, mortgage-type, would approximate $135 million. Clearly these outlays would have to be made in connection with the guarantees that existed between the companies that I have mentioned. Other factors would affect this, including a guarantee on bonds of Silver Bay Housing, and this would have net tax benefits, approximately $1 million of outlay required.

Notes receivable which the company has on its books with respect to housing, Silver Bay and Babbitt, might become uncollectible and this would give them a tax benefit potentially of $4.6 million.

From abandonment of property the tax benefits would approximate $50 million.

Or a net outlay, then, net of tax benefits, that is, would approximate $82 million.

Now, this is clearly a tentative, very partial, incomplete figure, but it does give some indication of the magnitude of outlays that would be required if facilities were to be abandoned. It doesn't include, for example, direct shutdown costs, does not include certain employee-related costs, such as those for separation pay, those for transfer of employees to other plants, and so forth. Nor does it include any realization from sale of properties or benefits from moving equipment to other sites.

It appears to me on the basis of the analyses made and the figures which have been cited for you that this company could continue as an economically viable unit with the addition of pollution control facilities of the type that were contained in Proposal No. 2. You must, of course, keep in mind all of the assumptions that were noted earlier in evaluating this opinion that has been given. Let me review for just a moment a few of some of the key items.

First, Reserve Mining is a component, a part, of the Armco Steel and Republic Steel Companies.

Second, profits would be reduced for the company significantly, though still remain substantial, if these facilities were added. Returns on net funds provided by participants after Federal income taxes would be just below the 20 percent level then.

Funds available after the installation of pollution control facilities would be $1.17, and this is based upon the 3-year ended 12-31-69 period.

Also funds available for the 20 years after installation of pollution control facilities would total approximately $230 million, though substantial amounts, of course, would be needed for improvements, and so forth.

I must close by emphasizing the assumptions that were a part of this analysis. The company in fact is a cost company and costs are treated as a part of the parent companies' costs. But to get at whether or not the company, Reserve Mining, could or could not be on an economic basis and remain on an economic basis with the installation of pollution control facilities, I believe they could and I believe the assumptions are reasonable under the circumstances.

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

If not, thank you very much, sir.

MR. FRANGOS: Mr. Chairman, will a copy of that statement be available to the conferees?

MR. STEIN: Do you have copies of his statement? Can we get an answer to that, Mr. Badalich?

MR. BADALICH: Mr. Chairman, I understand that copies aren't available now, but we will certainly furnish the conferees with a copy of this in the very near future. We haven't any right now, if that is what you mean, but we will make it available.

MR. FRANGOS: That will be fine, thanks.

MR. BADALICH: Mr. Chairman, we will continue. Mr. Friedell would like to continue with his statement.

LANE FRIEDELL
ASSISTANT ATTORNEY GENERAL
STATE OF MINNESOTA
(continued)

MR. FRIEDELL: Again, Mr. Chairman, conferees, ladies and gentlemen.

As I previously mentioned, the Attorney General of the State of Minnesota has been and is deeply involved in the specific problems of the Reserve Mining tailings discharge into Lake Superior. We have concluded a 7-week trial in which the Attorney General of Minnesota and the Pollution Control Agency have vigorously attempted to bring before the judiciary system of the State of Minnesota all the salient and pertinent facts which do show that Reserve Mining is polluting Lake Superior. They are depositing 67,000 tons a day of taconite tailings into the lake.

Reserve Mining has made the statement that they will operate under a 40-year plan, and at the end of that 40-year plan, assuming that that assumption that they have alluded to is correct, over one billion tons of taconite tailings will be deposited in Lake Superior. An even more interesting statistic is that during these 40 years, only saying that the deposition of tailings is a sediment load, if you compare that sediment load in 40 years to the sediment load of northshore Minnesota streams taking sediment into Lake Superior, Reserve will do in 40 years what the northshore streams would do in 15,000 years. Or to say it another way, it would take 20 generations, 20 generations would pass, before all of the streams that enter into Lake Superior contribute as much sediment load as Reserve will in the next 40 years.

It is the position of the Attorney General at the Lake County trial, it is his position now, that Reserve Mining is polluting Lake Superior.

The Pollution Control Agency and the Attorney General became involved very deeply in this particular problem when a lawsuit was filed on the 24th day of December 1969 by Reserve Mining. They alleged in that lawsuit that they (1) were not polluting Lake Superior, and (2) that two very important standards in the Water Pollution Control regulations, the antidegradation clause, nondegradation clause, and the effluent standards were unlawful and unreasonable as applied to Reserve. This the Attorney General has denied in his answer and he has asserted in a counterclaim, which means that the Attorney General in the State of Minnesota for the Pollution Control Agency has filed another lawsuit saying that not only is he denying this claim of Reserve, but saying in effect that Reserve was polluting Lake Superior in violation of Minnesota statutes and in violation of WPC 15.

This counterclaim was an aggressive act by the State of Minnesota to have an expedient answer to the question of whether or not Reserve is polluting Lake Superior.

At this 7-week trial the State of Minnesota showed that the effects of Reserve's discharges were the aging or eutrophication of Lake Superior, the deposition of significant dissolved solids in Lake Superior, discoloration of the water beyond the 1947 permit that was granted for Reserve's deposition. In addition there was a change in bottom fauna as a result of the tailings deposition, and in addition to that there was a stimulation of growth of algae by the addition of nutrients because of the 67,000 tons of tailings being deposited into Lake Superior daily.

On behalf of the State of Minnesota, the Attorney General and the Pollution Control Agency went across the country to obtain the best scientific people available to show that Reserve Mining was in fact polluting Lake Superior. Dr. Charles Goldman, Dr. Alfred Beaton, Dr. Joseph Shapiro, and Dr. Theodore Olson may not be common household names, but if you can analogize that to the game of golf, it would be like listening to Arnold Palmer, Jack Nicklaus and Gary Player talk about their game.

We contacted these people not only to comment on their understanding of the deposition of the tailings in Lake Superior, but they were also contacted to do studies. They made studies for us and presented their findings at the trial. These studies corroborated what the Federal Water Quality Administration studies, under the able leadership of Dr. Donald Mount, were able to find. And I would like to take this opportunity to say that the State of Minnesota Pollution Control Agency and the Attorney General are very grateful for the assistance and cooperation of the Federal people and their actions during this lawsuit. They provided us with much valuable assistance, as well as the cooperation for the studies that we presented for the Pollution Control Agency.

As I previously mentioned, and I wish to reiterate, these studies showed from a number of independent sources, from the scientists I have mentioned and from the Federal Water Quality Administration studies headed by Dr. Donald Mount, that there was eutrophication, contribution of dissolved solids, discoloration beyond the permit of 1947, stimulation of algal growth, changes in the bottom fauna, and certain biological activity.

A further basic question which we had to deal with under the Minnesota law concerned the economic feasibility of Reserve's adopting an alternative method of disposal. The studies presented by the Attorney

General and PCA show, and it is the opinion of the Attorney General and the PCA, that Reserve can change and should change their alternative method of disposal and it is economically feasible for them to do so.

Further on this subject, it was shown by the Attorney General that Reserve, as mentioned by the previous testimony from Dr. Berryman, is not a profit company and that the burden of preserving Lake Superior by assuming an alternative method would be assumed by the parent company. One proposal which was mentioned in Dr. Berryman's talk could cost each of the parent companies 45 cents per ton to provide for an alternative method. The Attorney General's opinion and that of the PCA is that this should be borne and can be borne economically by the parents of Reserve Mining Company in order that the pristine Lake Superior can be preserved for us today and for future Minnesota generations.

The PCA and the Attorney General have vigorously and promptly applied the law used by the PCA. Through the action of the PCA and the Attorney General Reserve has been challenged in its pollution of Lake Superior. We feel that undertaking this lawsuit the State of Minnesota has challenged Reserve's discharge into Lake

Superior in the most expedient manner and with the most effective and far-reaching laws and regulations presently available. I say this because of the fact that Minnesota has available an effluent standard which, as it was applied at the trial, shows that Reserve Mining is in violation of Minnesota laws and Minnesota regulations.

Minnesota does have the laws and regulations to protect its environment and the Attorney General and the PCA have made immediate use of those laws.

It is the Attorney General's opinion that only if Minnesota courts say that the State is incapable of acting on behalf of the people to preserve the unique characteristics of Lake Superior will it be necessary for action by the Federal Government. If the trial court says that we in Minnesota are incompetent to deal with our problem, then the Attorney General will recommend to the Governor to seek Federal assistance.

But we have the laws in Minnesota, we have the regulations, which I think are more far-reaching and more advanced than even the Federal's, and we have applied those laws with vigor.

Furthermore, the Attorney General pledges further aggressive action to protect our environment, especially the unique characteristics of Lake Superior. In regard to Reserve's discharge hearings in 1947, that permit hearing will be held as soon as the conclusion of the Lake County court is brought forth.

To summarize:

Attorney General Head believes that Reserve is polluting Lake Superior.

Secondly, that Reserve Mining should change its method of discharge and can economically change its method of discharge.

Our State laws and regulations, thirdly, are presently the most expedient and far-reaching tool to preserve our waters in the condition they are, and I speak most especially to Lake Superior water. If the courts do rule that we are incapable of protecting our environment ourselves, we will, then, recommend Federal assistance to the Governor.

And fourthly, as soon as the trial is over, the State will commence the hearing on the 1947 permit.

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

MR. FRANGOS: Yes, Mr. Chairman.

MR. STEIN: Yes.

MR. FRANGOS: I would like to ask Mr. Friedell, is there any kind of a time schedule that the District Court has established for concluding testimony and having briefs filed and when perhaps could you anticipate a decision?

MR. FRIEDELL: The testimony has been concluded. Reserve Mining Company and the State of Minnesota will submit briefs to the Honorable C. Luther Eckman by September 15. The decision will be in Judge Eckman's hands and will be forthcoming from him.

MR. STEIN: Are there any other comments or questions?

Mr. Friedell, I am going to refrain, as I always do, from commenting on the substance of any case before a Federal or State court until it is decided. But on the procedure in that case, I know we supplied 11 witnesses, I counted 11, plus a lawyer we sent up here who was practically in residence, and I notice when you called the roll call of distinguished people the Federal people weren't mentioned at all, except one who came in the back door, Dr. Mount. (Laughter.)

Now, let me make another assumption. If I heard you correctly, you want the-- You think Reserve is polluting. That is what you say. And you said in the suit the Attorney General thinks it is. And I assume if they are polluting, you want it corrected as soon as possible. Is this correct, you want it to stop that pollution?

MR. FRIEDELL: Absolutely.

MR. STEIN: Well, if you want it to stop that pollution and the pollution can be stopped, say, other than by State action, say by the Corps of Engineers by adjusting the permit, or by Federal water pollution control action by the Department of the Interior, then certainly you wouldn't object to that. You might not ask for it, but you are not going to stand in the way and talk about States rights, are you?

MR. FRIEDELL: I don't believe I brought up the subject, sir. (Laughter.)

MR. STEIN: No. I have heard it here. I am bringing up the subject. I want to know where the Attorney General's office is going to stand. If the idea is that you want to stop this pollution as rapidly as possible, then presumably you want to use whatever avenue you can, State, Federal, or what-have-you, and I assume that you don't want to hold onto a theory, perhaps, in this field of States rights which is going to stop the Federal Government from acting if it is going to keep the pollution going which you say occurs a little longer.

MR. FRIEDELL: I thought I answered that question twice, once in the body and once in the summary. The Attorney General will, if the decision in the District Court says that the State of Minnesota is incapable under its laws of doing anything, ask for Federal assistance.

MR. STEIN: That wasn't my question. I understood what you said. We have a Federal law and also we have two Federal laws that I see apply here. One, the company has a Corps of Engineers permit. I am making no judgment on the validity of that or not.

Secondly, if there is interstate pollution, we can proceed.

In other words, you would have absolutely no objection to appropriate action being taken under Federal law if that were considered the thing to do, to go ahead and abate this pollution, if it possibly could be done just a little faster than the State? Maybe we can engage in friendly rivalry, if this is the case, and see who can do this faster. (Laughter.)

MR. FRIEDELL: I am sure that the position of the PCA and also the position of the Attorney General would be that our interest is in stopping pollution.

MR. STEIN: That is what I thought. (Laughter.)

MR. FRIEDELL: And as a consequence, we look at the laws, our law and the Federal law, and I believe it was mentioned in the papers that the Federal law might be more expedient. But I sat down with a little pencil and paper and figured out the flow as it would be from the Federal law and it ended up what we have done would be commenced two or three years in the future.

So in answer to your question, we have proceeded as expediently as can be possible. We have vigorously applied our laws and--

MR. STEIN: I don't object to that. Mr. Friedell, let me make the point clear. We put our people where my mouth is. I sent 11 witnesses to support you in the case. Now, what are you going to do to support us in the Federal action? (Applause.)

MR. FRIEDELL: You have our support.

MR. STEIN: Thank you. (Laughter.)

MR. FRIEDELL: And by the way, Mr. Stein, I thought I had mentioned I was very grateful for the assistance.

MR. STEIN: I know that.

MR. FRIEDELL: And cooperation. I thought I had made it public, but I will say it again too.

MR. STEIN: Thank you.

Any other comments or questions?

If not, thank you very much, sir.

MR. BADALICH: Mr. Chairman.

MR. STEIN: Yes.

MR. BADALICH: We will continue with the Minnesota presentation. I would like to call upon Mr. Fred Cina, former State legislator, who is appearing on behalf of many municipalities and villages in the Lake Superior Basin.

Mr. Cina.

FRED A. CINA
VILLAGE ATTORNEY
VILLAGES OF BABBITT AND HOYT LAKES
AURORA, MINNESOTA

MR. CINA: Mr. Chairman and members of the conference.

I really don't represent these communities, but they were here and were requested to appear at the conference by our Agency.

The request was to present our position on providing or what we are going to do with sewage treatment as far as sewage treatment facilities are concerned and what we are going to do with the separation of sanitary and storm sewers and what our intentions are. I am authorized to make this statement in behalf of the following communities and we have filed a statement with the conference which is signed by the proper authorities from these communities.

All of the above cities and villages say that they will make every effort to comply with the Agency's schedule for updating sewage treatment facilities to provide secondary and/or tertiary treatment and to separate sanitary and storm sewers. They intend to hire consultants to prepare a preliminary engineering report. However, until these reports are completed and the proposed costs are calculated, they are hesitant to make a firm commitment for the timing of the actual construction.

The date set by the Minnesota Pollution Control Agency is 1975 and many of these communities are making the necessary tests now and have hired consultants to assist them in meeting the standards set by the State Pollution Control Agency. One of the difficulties, Mr. Chairman and members of the conference, is that of employing consultants that are capable and able to present to these communities plans that will meet the requirements of the Agency. They have every intention of doing this, and we certainly hope that the Basin, which most of these communities are part of, will be cleaned up and that they will not be contributing to pollution of the Lake Superior Basin in the future.

Thank you very much.

MR. STEIN: Thank you.

(Which statement follows:)

**ROBERT R. WALLACE
AND ASSOCIATES, INC.**

ROBERT R. WALLACE, President
JOHN J. BAKER, Vice President

MINING ENGINEERING - CIVIL ENGINEERING - LAND SURVEYING
2031 Second Ave. E. Hibbing, Minnesota 55746
Post Office Box 481 Area Code 218 262-3200

August 11, 1970

State Pollution Control Agency

Gentlemen:

Our firm has been instructed to represent the following communities at this meeting:

Bovey - Coleraine
Chisholm
Eveleth
Gilbert
Kinney
Taconite
Town of Stuntz

All of the above towns have authorized us to say that they will make every effort to comply with the Agency's schedule for updating sewage treatment facilities to provide secondary and/or tertiary treatment and to separate sanitary and storm sewers. They intend to hire a consultant by 9-1-70 to prepare a preliminary engineering report, however, until the engineering report is completed and the proposed costs are calculated the towns are hesitant about making a firm commitment for the timing of the actual construction.

Yours truly,

John J. Baker

John J. Baker, P.E.

MR. STEIN: Are there any comments?

I think that is a very constructive statement. Are there any comments or questions?

I would like to just make a generalized comment. I know the consultants on this are very shorthanded and these communities are finding a hard time to get the consultants, and a lot of these communities, I take it, Mr. Badalich, are relatively small and don't have too much money. Isn't that correct?

MR. CINA: Mr. Chairman, I will answer the question for Mr. Badalich. Most of the communities are small.

MR. STEIN: Right.

MR. CINA: There are many consulting firms that have been promoting these communities, but we in the area that I represent--and this is known as the iron range area--we feel we want the best. We just don't want somebody to be a consultant because he says he is. We want a person that we can rely upon to cure our problems and to settle this question once and all for us.

MR. STEIN: Sir, I appreciate your plight and I know the situation. You are bidding for these consultants with much richer companies and places where they hire them to fight the pollution action. If they are engaged in fighting them, they sure can't be working at your prices to clean it up.

MR. CINA: Very true. (Laughter.)

MR. STEIN: Thank you.

MR. CINA: Thank you.

MR. STEIN: Mr. Badalich.

MR. BADALICH: Thank you, Mr. Cina.

Mr. Chairman, I would like to next introduce State Senator Wendell R. Anderson, of St. Paul. I would like to introduce him to the conference.

Senator Anderson is the DFL candidate for Governor for the State of Minnesota.

Here is Mr. Anderson.

WENDELL R. ANDERSON
STATE SENATOR
ST. PAUL, MINNESOTA

SENATOR ANDERSON: I want to thank the members of the conference for being so polite as to put me on at this time to allow me to speak just very, very briefly. I won't take more than just a couple of moments.

I recognize that anything a candidate says is sometimes suspect, but I do believe a candidate also has something on occasion to offer.

In the last year and a half I had an opportunity to visit every one of Minnesota's 87 counties. I had a chance not only to speak to people, but I had an opportunity to listen to them. I have appeared before over 150 groups, farm groups, labor groups, business groups, college campuses.

They all have one thing in common, whether they are young or old -- they are concerned about our environment. They are nervous about the situation. They know that not enough is being done and they are concerned about Lake Superior and they don't understand why we don't do something about it. They are looking for some action, they are looking for some help. They want tough, firm, fair action and they want it now.

I think the people of Minnesota have demonstrated to me and they have demonstrated, I think, to all of you that they have faith in our political system, that it is still possible to get something done within the framework of the 2 party system if we can demonstrate that we are going to be responsive.

For my part, I want you to know that if I am elected one of the first acts would be to formally join

Minnesota in this conference. It should have been done over a year ago, but that is one of the very first acts that I will take. I hope by then that it won't be necessary. I hope that you will require Reserve Mining to begin immediate construction of disposal facilities on shore, that Reserve's permits be revoked and only conditional permits be issued until construction is completed, and that a specific timetable be established for the total cessation of dumping of taconite tailings into Lake Superior by December 31 of 1972.

I believe the request is reasonable. None of us are anti-business. We are pro people, we are pro clean water, we are pro Lake Superior. Thousands of concerned people in Minnesota are watching your efforts and hoping. You will have my support, you will have their support if you take firm, tough, immediate action.

Thank you very much.

(Applause.)

MR. STEIN: Thank you, Mr. Anderson, for your statement.

SENATOR ANDERSON: Thank you very much.

MR. STEIN: We appreciate having you here.

SENATOR ANDERSON: You bet.

MR. STEIN: Mr. Badalich.

MR. BADALICH: Mr. Chairman, continuing with the Minnesota representation, I would like to call upon Mr. Herb Dunsmore from Pittsburgh, who is here to make a statement on behalf of the United States Steel Corporation, Duluth Works.

MR. STEIN: That is Pittsburgh, Pennsylvania, isn't it?

MR. BADALICH: Did I say something else?

MR. STEIN: No, no. But there are a lot of Pittsburghs.

MR. BADALICH: Oh, I am sorry. Pittsburgh, Pennsylvania.

MR. STEIN: Right. There is a Pittsburg, Kansas. That is where the boys used to head off for a weekend from Camp Crowder. (Laughter.)

HERBERT J. DUNSMORE

DIRECTOR FOR ENVIRONMENTAL CONTROL

U. S. STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

MR. DUNSMORE: Mr. Chairman, conferees, ladies and gentlemen.

H. J. Dunsmore

My name is Herbert J. Dunsmore. I am Director for Environmental Control for United States Steel Corporation, and my responsibilities include the area of air and water pollution control.

I am pleased to have this opportunity to appear at this reconvened Federal-State enforcement conference on Lake Superior and its tributary basin.

Prior to the first of these conferences, which was held in May of 1969, discussions had already been initiated and were then in progress between the United States Steel Corporation and the Minnesota Pollution Control Agency involving a consideration of the industrial waste discharges from the Duluth Steel Works. A program for their prompt implementation has since been negotiated. It is my understanding that the existence and continuation of these discussions were noted to this conference by Mr. Badalich.

It may be noted that the United States Steel Corporation facilities at Duluth, involving not only an integrated steel plant but also a cement plant, as was shown this morning in the photographs, have been facing a double problem involving both air and water quality. The discussions and negotiations between our company and the Agency have reflected these inherent difficulties.

On June 19, 1970, at a special meeting of the Agency, they adopted a resolution accepting the program of United States Steel Corporation for improving air and water quality for the corporation's Duluth facilities. This conference on Lake Superior is, of course, concerned only with water conditions, and plans and application for construction permit have already been submitted by our corporation to the Agency for the first of the three improvements called for by that program and we are now proceeding as rapidly as possible to implement this plan.

Thank you for the opportunity to present this statement.

MR. STEIN: Thank you, Mr. Dunsmore.

Just a moment. You want your whole statement to appear in full?

MR. DUNSMORE: Yes. This was just a summary of the statement and I would request that.

(Which statement follows:)

STATEMENT BEFORE

THE CONFERENCE ON POLLUTION OF LAKE SUPERIOR AND ITS TRIBUTARY BASIN

RADISSON DULUTH HOTEL
DULUTH, MINNESOTA

August 12-13, 1970

By

Herbert J. Dunsmore
Director-Environmental Control

United States Steel Corporation
525 William Penn Place
Pittsburgh, Pennsylvania

My name is Herbert J. Dunsmore. I am the Director of Environmental Control at United States Steel Corporation and my responsibilities include the area of air and water quality control.

I am pleased to have this opportunity to appear at this reconvened Federal-State Enforcement Conference on Lake Superior and its tributary basin.

Prior to the first of these conferences, which was held May 13 through May 15, 1969, discussions had already been initiated and were then in progress between United States Steel Corporation and the Minnesota Pollution Control Agency involving a consideration of the industrial waste discharges from the Duluth Steel Works' steel producing facility at Duluth, Minnesota, and a possible program for improvements with respect to such discharges. It is my understanding that the existence and continuation of such discussions were noted in a report from Mr. John P. Badalich, Executive Director of the Minnesota Pollution Control Agency, at the reconvened Lake Superior Enforcement Conference on April 29 and April 30, 1970.

It may be noted that the United States Steel Corporation facilities at Duluth, involving not only an integrated steel plant but also a cement plant, have been faced with a double problem involving both air quality and water quality. The discussions and negotiations between our company and the MPCA have reflected these inherent difficulties.

On June 19, 1970, at a meeting of the MPCA the Agency adopted a resolution accepting the program of United States Steel Corporation for improvements in air and water quality at the Corporation's Duluth Steel Works and Universal Atlas Cement Plant, as stated in a letter dated June 17, 1970, from USSC to Mr. Badalich. This Conference on Lake

Superior is, of course, concerned only with water conditions.

The program of improvements stated in USSC's letter of June 17, 1970, and accepted by the MPCA on June 19, insofar as it applied to water conditions involved the following commitments by United States Steel Corporation:

1.	Installation of a controlled lubrication system in the Merchant Mill.	
2.	Installation of additional oil skimming and removal facilities complete with necessary auxiliaries and utilities at the Wire Mill settling basin.	July, 1971
3.	Installation of a chlorination system complete with chlorine storage building and necessary auxiliaries and utilities for the reduction of the coliform content in the Wire Mill outfall which serves the rolling mills, fence post fabrications, open hearth, wire mill and maintenance shop wash houses.	December, 1970
4.	Maintenance of the existing settling basins at optimum solids removal efficiency; determination of effective coagulant aids for blast furnace waste water to improve flocculation and settling; and taking other reasonable steps that may be effective in improving the turbidity and suspended solids of the blast furnace outfall.	July, 1970

5. Construction of a sewer line to municipal system for sanitary wastes and other organic wastes amendable to biological treatment from coke plant and blast furnace areas that is acceptable to the municipal authority. November 28, 1970

In addition, United States Steel Corporation stated that it is making studies of the economics of long range production of steel and cement in Duluth to determine a course of action. The conclusions of these studies will be transmitted to the MPCA as promptly as possible but no later than July 1, 1973. If such economic studies indicate the feasibility of continuing steel and cement operations at the Duluth locations, United States Steel Corporation will take appropriate steps to meet Minnesota Pollution Control air and water standards according to a specified schedule calling for either corrective installations or removal from service of affected facilities by July 1, 1975.

The reasons and background circumstances which provided the basis for the United States Steel Corporation program for improvements have been brought to the attention of the MPCA in various letters to and oral presentations before the MPCA. In summary, these circumstances and considerations are as follows:

1. All of the steelmaking facilities are over 50 years old.
2. The operation of these facilities is marginal from a competitive and economic standpoint and these marginally competitive conditions have very seriously aggravated the already difficult program of working out a program pointed towards compliance.

3. The Corporation's steel plant in Duluth is the City's largest employer with approximately 2,500 employees representing a very large portion of the total employment in the City of Duluth.
4. A large number of other employed labor, businesses and industries are indirectly dependent upon the continued operation of this plant.

Plans have already been submitted by United States Steel Corporation to the Minnesota Pollution Control Agency for the first three improvements called for by the program.

Respectfully submitted by:

UNITED STATES STEEL CORPORATION

by: Herbert J. Dunsmore, Director
Environmental Control

MR. STEIN: If you would just wait. I really don't have any questions, but I want to emphasize a point here, Mr. Dunsmore.

I think the guts of the proposal as far as a checkout and that U. S. Steel has given us are contained in portions that Mr. Dunsmore has not read.

Now, Mr. Dunsmore is one of the top professionals, in my opinion, in this field, anywhere, government or industry, and believe it or not, years ago he used to work for the government.

Maybe I shouldn't reveal that, Herb.

MR. DUNSMORE: Yes, I am proud of it.

MR. STEIN: Same agency as us.

But I think if we go down the list, because we communicate on this very well, he talks about, for example, installation of controlled lubrication system in the Merchant Mill, and a date; installation of additional oil skimming and removal facilities complete with necessary auxiliaries and utilities of the Wire Mill settling basin, and a date; installation of chlorination system complete with chlorine storage building and necessary auxiliaries and utilities for the reduction of the coliform content in the Wire Mill outfall which serves the rolling mills, fence post fabrications, open hearth, wire mill and maintenance shop wash houses; and other basins--I won't read all of these--maintenance of existing settling basins, and so forth.

I think, and again I speak for the public, I speak for the conferees, for the press, what-have-you, when you get detail like this everyone can make a judgment whether U. S. Steel is doing its job, whether the State people are doing their job, whether the Federal Government is doing its job. In the absence of this specificity we are just talking, really talking to formulate the plans.

I often say this, don't fire until you see the whites of their eyes. I don't think you have anything until you begin getting the kind of industrial plant, until you get the kind of specificity that we have gotten today from U. S. Steel. Any less, you can't make the judgment. And if the analogy fits anywhere, so be it.

Thank you, Mr. Dunsmore. (Applause.)

MR. BADALICH: Mr. Chairman, to continue, I would like to call upon Mr. Harry Grounds, of Toltz, King, Duvall, Anderson, of St. Paul, for a statement on behalf of McKinley, Minnesota.

HARRY C. GROUNDS, P. E.

TOLTZ, KING, DUVALL, ANDERSON AND ASSOCIATES INCORPORATED, ENGINEERS AND ARCHITECTS

ST. PAUL, MINNESOTA

MR. GROUNDS: My name is Harry C. Grounds. I am a registered professional engineer and I am with the firm of Toltz, King, Duvall, Anderson and Associates Incorporated, in St. Paul, Minnesota.

We have been retained by McKinley, Minnesota, to begin a study of their waste treatment needs, and I have been asked to read the following letter into the record here today:

"John P. Badalich, P.E.
Executive Secretary
State of Minnesota
Pollution Control Agency
Minneapolis, Minnesota

"Dear Mr. Badalich:

"The Honorable Frank J. Siskar, Mayor, McKinley, Minnesota, has requested that I enter the following statement into the record of this conference.

"As outlined previously to your Agency the situation regarding McKinley is somewhat unique in that at some future date the Village will be taken over for purposes of taconite mining. Attachment'A' submitted herewith"--and I will not read that attachment--"is a copy of a letter from Herbert Johnson, Vice-President, Jones and Laughlin Steel Corporation, stating their acquisition of mining rights in and around McKinley.

"Because the timetable for construction of the taconite mining facility is indefinite, the Village of McKinley intends at this time to conform to a schedule for planning and construction of treatment facilities outlined in Attachment 'B.' This schedule was discussed with your Agency and conforms with the recommendations of the conferees.

"Very truly yours, Toltz, King, Duvall, Anderson and Associates, Incorporated, Harry C. Grounds."

Thank you.

(Which letter, with attachments, follows:)

TKDA TOLTZ, KING, DUVALL, ANDERSON AND ASSOCIATES INCORPORATED
ENGINEERS AND ARCHITECTS
1408 PIONEER BUILDING
SAINT PAUL, MINNESOTA
55101 224-7891

PHILIP E. ASKEW
GERALD P. ANDERSON
OWEN J. BEATTY
JAMES C. BROTEN
ARNOT J. DUVALL
HUGO G. ERICKSON
WILLIAM J. FEYDER
ROYCE B. HANSEN
DUWAYNE R. KASMA
J. THOMAS KIRK
OSCAR L. LILJA
A. DEAN LUNDHOLM
ROBERT T. MALONEY
WAYNE A. OLSON
DUANE T. PREW
RUDOLPH P. RAITOR
ROBERT R. RYDER
WILLIAM T. SHERIDAN
ABE J. SPERLING
ARNOLD M. STEFFES
WALTER W. THORPE
JAMES E. VOYEN
NATHAN F. WEBER
ORVILLE K. WRIGHT

August 12, 1970

John P. Badalich, P.E.
Executive Secretary
State of Minnesota
Pollution Control Agency
Minneapolis, Minnesota 55440

Re: Lake Superior Hearing
August 12 and 13, 1970
Statement on Behalf of
McKinley, Minnesota
Commission No. 5594

Dear Mr. Badalich:

The Honorable Frank J. Siskar, Mayor, McKinley, Minnesota has requested that I enter the following statement into the record of this conference.

As outlined previously to your Agency the situation regarding McKinley is somewhat unique in that at some future date the Village will be taken over for purposes of taconite mining. Attachment "A" submitted herewith is a copy of a letter from Herbert Johnson, Vice-President, Jones and Laughlin Steel Corporation stating their acquisition of mining rights in and around McKinley.

Because the timetable for construction of the taconite mining facility is indefinite the Village of McKinley intends at this time to conform to a schedule for planning and construction of treatment facilities outlined in Attachment "B". This schedule was discussed with your Agency and conforms with the recommendations of the Conferees.

Very truly yours,

TOLTZ, KING, DUVALL, ANDERSON
AND ASSOCIATES, INCORPORATED

Harry C. Grounds
Harry C. Grounds

HCG:ma

ATTACHMENT A

JONES & LAUGHLIN STEEL CORPORATION

3 GATEWAY CENTER

PITTSBURGH, PA. 15230

HERBERT JOHNSON
VICE PRESIDENT-GENERAL SERVICES

Toltz, King, Duvall, Anderson
and Associates, Incorporated
RECEIVED
AUG 7 '70
MR. DUVALL ✓
MR. SPE[illegible]
REF. TO Grounds
ACTION BY
DATE

July 23, 1970

The Honorable Frank J. Siskar, Mayor
McKinley, Minnesota
55761

Dear Sir:

I have been asked by Mr. Harry C. Grounds of TDKA to write to you with respect to Jones & Laughlin Steel Corporation's plans for mining in the McKinley area.

As you are undoubtedly aware, J&L has acquired the mining rights to most of the taconite lying between Gilbert and Biwabik, including the area in and around McKinley. We have developed extensive plans to construct a taconite facility in the area, but, for various reasons we have been unable to implement these plans and get moving on the project. As of this time, the timetable for the project is still indefinite.

We have no specific policy or timetable for acquiring homes in McKinley. However, it has been our practice, to the extent that funds are available, to purchase homes at fair values in the event that an owner wishes to sell and cannot find a buyer. We intend to continue this practice, but at this time we cannot even speculate as to the probable timetable of future purchases.

Sincerely,

Herbert Johnson

Herbert Johnson

s

ATTACHMENT B

TIMETABLE FOR PLANNING AND CONSTRUCTION OF TREATMENT WORKS

ITEM	DATE TO BE ACCOMPLISHED
Effluent Disinfection or Equivalent	As soon as practicable
Retain Consulting Engineer	Completed April 1970
Engineering Report on Secondary Treatment and Phosphorous Removal	March, 1971
Authorize Final Plans	April, 1971
Completion of Final Plans on Secondary Treatment and Phosphorous Removal	October, 1971
Award of Contract	April, 1972
Secondary and Phosphorous Removal Works Completed and Operating By	January, 1975

MR. STEIN: Thank you.

May I ask you one question, Mr. Grounds?

MR. GROUNDS: Certainly.

MR. STEIN: On your Attachment B, go down just before your last item, can you tell us when you are going to award the contract?

MR. GROUNDS: That is dated April--

MR. STEIN: April 1972.

MR. GROUNDS: Right.

MR. STEIN: I see it. I missed it.

MR. GROUNDS: That is right.

MR. STEIN: I see. Thank you.

Mr. Grounds also used to be with us. You know, you fellows give me an idea. Instead of calling these conferences I am going to call them alumni meetings and charge admission. (Laughter.)

MR. GROUNDS: Thank you.

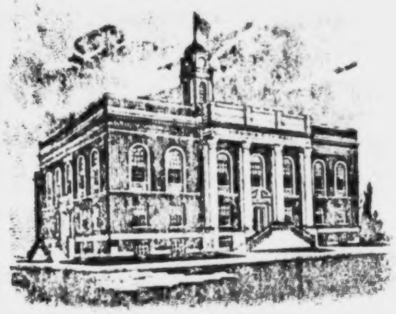
MR. BADALICH: Mr. Chairman, I have a statement from Virginia, Minnesota, to be made by Mr. W. Liebenow, of the Bannister Engineering Company. I don't know whether he is here.

If not, I will enter this statement in the record.

MR. STEIN: Without objection, that will be entered as if read.

(Which said statement follows:)

J. EDWARD PEARSALL, Mayor



CITY OF VIRGINIA
OFFICE OF
MAYOR
VIRGINIA, MINN.

August 10, 1970

Minnesota Pollution Control Agency
717 SE Delaware Street
Minneapolis, Minnesota 55440

Gentlemen:

In reply to your letter of July 23, 1970, regarding the Lake Superior Basin Pollution Conference, please be advised that the following action has been taken by the City of Virginia, Minnesota.

1. Sampling and testing as required for a Class "B" plant was begun on June 15, 1970. The Report for June has been sent to you and the July Report will be sent shortly.

2. On June 9, 1970, the City Council approved a contract with Banister Engineering Company of St. Paul, Minnesota to prepare a preliminary report on improvements and additions necessary to the wastewater treatment plant to provide effluent chlorination, phosphorus reduction, and elimination of bypassing of untreated wastewater. This report will be completed by late 1970.

With regard to combined sewers, please be advised that to our knowledge, no combined sewers exist in Virginia.

We trust this information fulfills the request in your letter.

Very truly yours,

CITY OF VIRGINIA

J. Edward Pearsall

J. E. Pearsall, Mayor

cc: City Council, c/o Paul L. Lundmark, City Clerk
Valentine Bazzani, Acting City Engineer
Milton Logan, City Attorney
Dr. David A. Sher, Health Officer
Banister Engineering Company

MR. STEIN: We will recess for 10 minutes.

(RECESS)

MR. STEIN: We will reconvene.

Mr. Badalich, will you continue.

MR. BADALICH: I would again like to put Mr. Lane Friedell at the podium to introduce another witness for a statement for Minnesota.

LANE FRIEDELL
ASSISTANT ATTORNEY GENERAL
STATE OF MINNESOTA

MR. FRIEDELL: Mr. Chairman, before I introduce Dr. Shapiro, the State of Minnesota would like to append to this conference record, when it is available, the transcript of the trial at Two Harbors.

MR. STEIN: May we make that an exhibit?

MR. FRIEDELL: Yes, if you like. (Laughter.) When that transcript is available; I am not sure when.

MR. STEIN: Yes. All right. We will certainly get it as an exhibit.

Thank you.

(The transcript referred to is marked Exhibit 2 and is on file at the FWQA Headquarters in Washington, D.C., with a copy on file at the FWQA Regional Office in Chicago, Illinois.)

MR. FRIEDELL: Secondly, the State of Minnesota Pollution Control Agency wishes to also put in as an exhibit a report from Dr. Charles Goldman, Institute of Ecology, University of California, Davis, entitled "Taconite Tailings as a Biostimulant for Algal Growth in Lake Superior."

MR. STEIN: How about putting that in its entirety in the record as if read? That isn't too long, is it?

MR. BRYSON: No.

MR. FRIEDELL: If I may, I would ask Dr. Shapiro to read it, since he would be a better reader than I.

MR. STEIN: We can include it in the record as if read, but it can be summarized by Dr. Shapiro.

MR. FRIEDELL: All right.

MR. STEIN: But it will appear in the record in its entirety.

MR. FRIEDELL: Yes.

MR. STEIN: All right. Thank you. May we have copies of Dr. Goldman's paper, if possible? And if there is just one copy, I would like the staff to reproduce it and give it to the conferees.

MR. FRIEDELL: Dr. Goldman's paper, a number of copies are available, I don't believe enough for the entire conferees.

MR. STEIN: We have a duplicating situation here. We can get it. Why don't you let Mr. Corrado have a copy of that and he will have it duplicated in sufficient quantities for the conferees.

(Which report follows:)

Taconite Tailings as a Biostimulant for Algal Growth in Lake Superior

by Charles R. Goldman, Ph.D.

Institute of Ecology
University of California
Davis, California 95616

Introduction

Considerable attention has recently been directed towards the daily disposal of 67,000 long tons of waste taconite grindings from the Reserve Mining plant at Silver Bay, Minnesota. To extract the magnetite efficiently, the ore is thoroughly crushed so that 40% of the wastes are reported to be less than 44 microns and about 3% less than 2 microns. The larger particles settle out in a delta deposit growing out from the plant, while the finer particles may be transported considerable distances by the lake currents and may be resuspended in shallow water by wave action. The taconite tailings are thus a very significant source of sediment for the lake as well as turbidity in the vicinity of the plant. Of particular importance in the present report is the fact that the tailings are a source of dissolved elements which have been estimated at 160,000 pounds per day. The work reported here was directed towards an evaluation of taconite tailings as a nutrient source for the natural population of Lake Superior phytoplankton.

Methods

Several gallons of Lake Superior water were collected well north of the disposal area and airshipped in insulated, inert containers to the laboratory together with a sample of the fine material collected beyond the delta edge at the Silver Bay plant. The bioassay technique of utilizing cultures of the natural phytoplankton population and 14-carbon to measure growth rate was employed (Goldman, 1960, 1963). Two experiments were performed. The first involved additions to the Lake Superior water of 0.1, 1, and 10% by volume additions of the filtered (HA Millipore®) and unfiltered fine tailings. Because of the ability of iron complexes under certain conditions to adsorb 14-carbon (Goldman and Mason, 1962) a control was included with filtered Lake Superior water so that any abiological deposition of 14-carbon could be detected.

These values were subtracted from the experimental values which then represent only biological uptake of 14-carbon under the varied experimental additions of taconite indicated. The first 72 hours of the experiment were run in continuous light at 15° C with mild shaking. The second experiment involved graded additions of 0.0001, .001, 0.01, 1, and 10% by volume to Lake Superior water and included duplicate cultures of both the control and the filtered and unfiltered taconite. The radioactivity of the filtered algae expressed as counts per minute was determined with a Nuclear-Chicago® gas flow tin window G.M. automatic counter.

Results

Analysis of the Lake Superior water used in these experiments indicated that there is probably a general phosphorus limitation in this Lake Superior water. It contained 243 ppb NO_3^- - N, less than 1 ppb PO_4-P (soluble phosphorus). Iron content was high, at 32 ppb Fe.

In the two culture experiments reported here the taconite was found to stimulate the growth of the natural phytoplankton population. In the first experiment the 0.1% taconite was more stimulating than the 1%

additions (figure 1). In the second and third experiments where a greater range of concentrations were used, the most immediate response was at 0.001% taconite addition to the Lake Superior water. This was after an incubation of 18 hours (figure 2). After 84 hours had elapsed (figure 3) there was stimulation at all levels from 0.0001 to 10% with an optimum in the range of 0.001 to 0.1 percent by volume additions. Above 0.1% by volume addition to the culture the growth response appears to reflect the beginning of inhibition. This may reflect excessive concentration of the stimulating micronutrients or inhibitory concentrations of other elements already present in non-limiting concentrations.

Discussion

The response of the Lake Superior phytoplankton to filtered and unfiltered taconite tailings is very similar to the trace element response reported by Goldman (1960b, 1964, and 1965). It is characterized by an almost immediate change in the initial rate of photosynthesis which persists throughout the experiment without further change. This suggests that an immediate need for one or more elements is met and the cellular machinery then continues to work at a slightly elevated rate paralleling the control. Had there been more available phosphorus it is likely that the response would have been still greater. Trace element involvement is also indicated by the tendency of the cultures not to show a simple concentration response. It is likely that some trace elements such as copper may be inhibiting at the higher concentrations. It would be of considerable interest to identify the specific growth factors in subsequent experiments and work out their interactions. During the next few decades, as more phosphorus inevitably finds its way into Lake Superior, it is probable that the nutrients now only mildly stimulating will provide an additive effect on the growth of phytoplankton and periphyton alike.

In general it can be concluded from these experiments that the taconite tailings are a mild fertilizer for the lake phytoplankton and are of importance when viewed from the standpoint of the enormous quantities entering this highly sensitive, oligotrophic environment. A casual inspection of the Lake Superior shoreline by the author showed a luxuriant growth of periphyton. These have been the subject of a study by Fox, Odlang, and Olson (1969) and deserve continued study as indicators of eutrophication. The periphyton were the first obvious sign of the early stages of eutrophication of ultra-oligotrophic Lake Tahoe (Goldman and Armstrong, 1969). The tremendous volume of Lake Superior lying beneath the 31,820 square miles of surface area has a great buffering capacity. We have learned rather late that even the great volume of the oceans is not a bottomless disposal area for the wastes of our techniques.

Global pollution has finally been recognized by even the most sceptical. Our freshwater resources are of ever increasing importance as our population expands. Every effort should be made to stem the flow of nutrients into them if we hope to preserve our vanishing natural resources.

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____and D. T. Mason. 1962. Inorganic precipitation of carbon in productivity experiments utilizing C^{14}. Science 136: 1049-1050.

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Fox, J. L., T. O. Odlaug, and T. A. Olson. 1969. The ecology of periphyton in Western Lake Superior: Part I. Taxonomy and distribution. Water Resources Research Center, Univ. of Minnesota, Bull. 14. 127 pp.

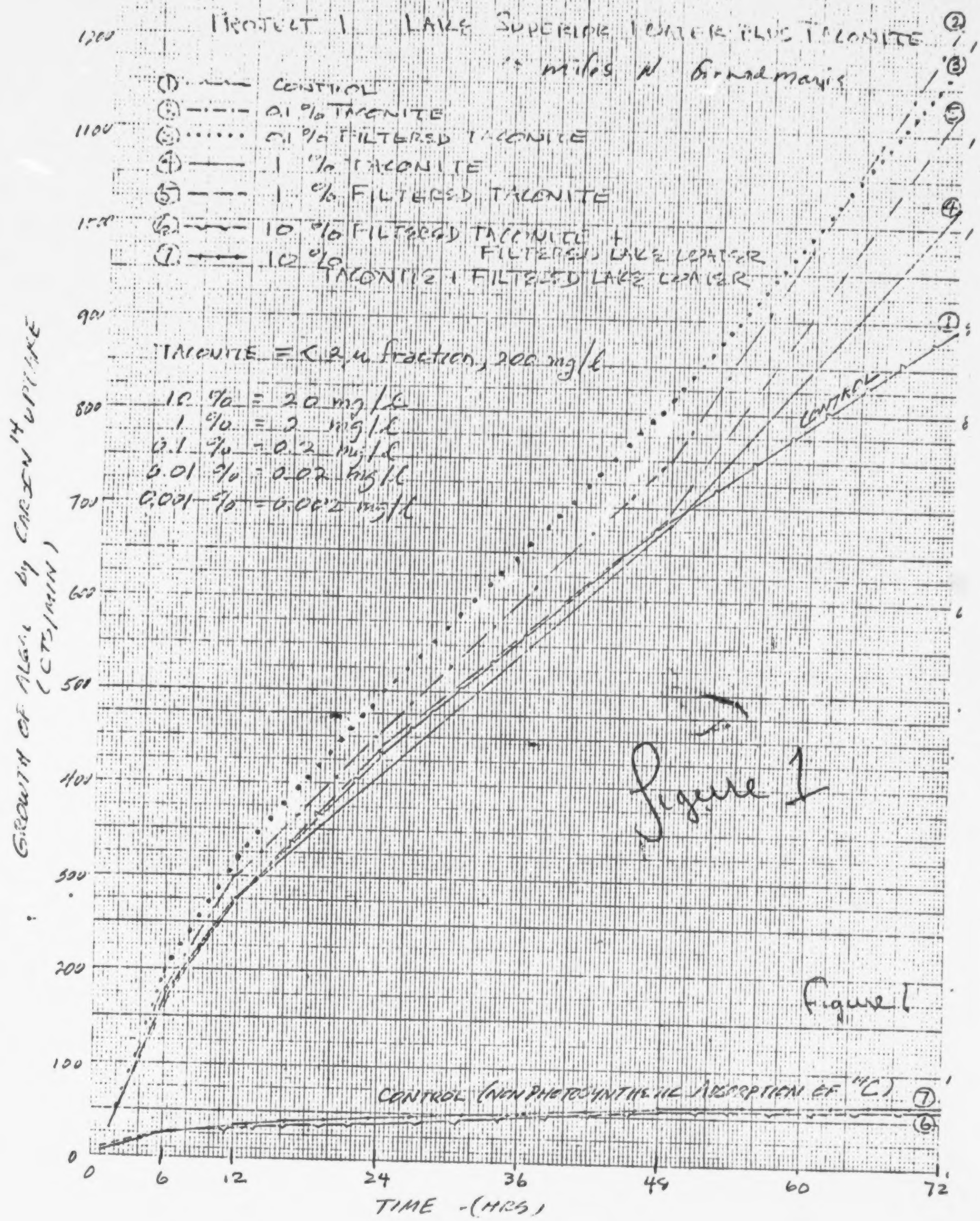


Figure 1

figure 1

Reproduced from best available copy.

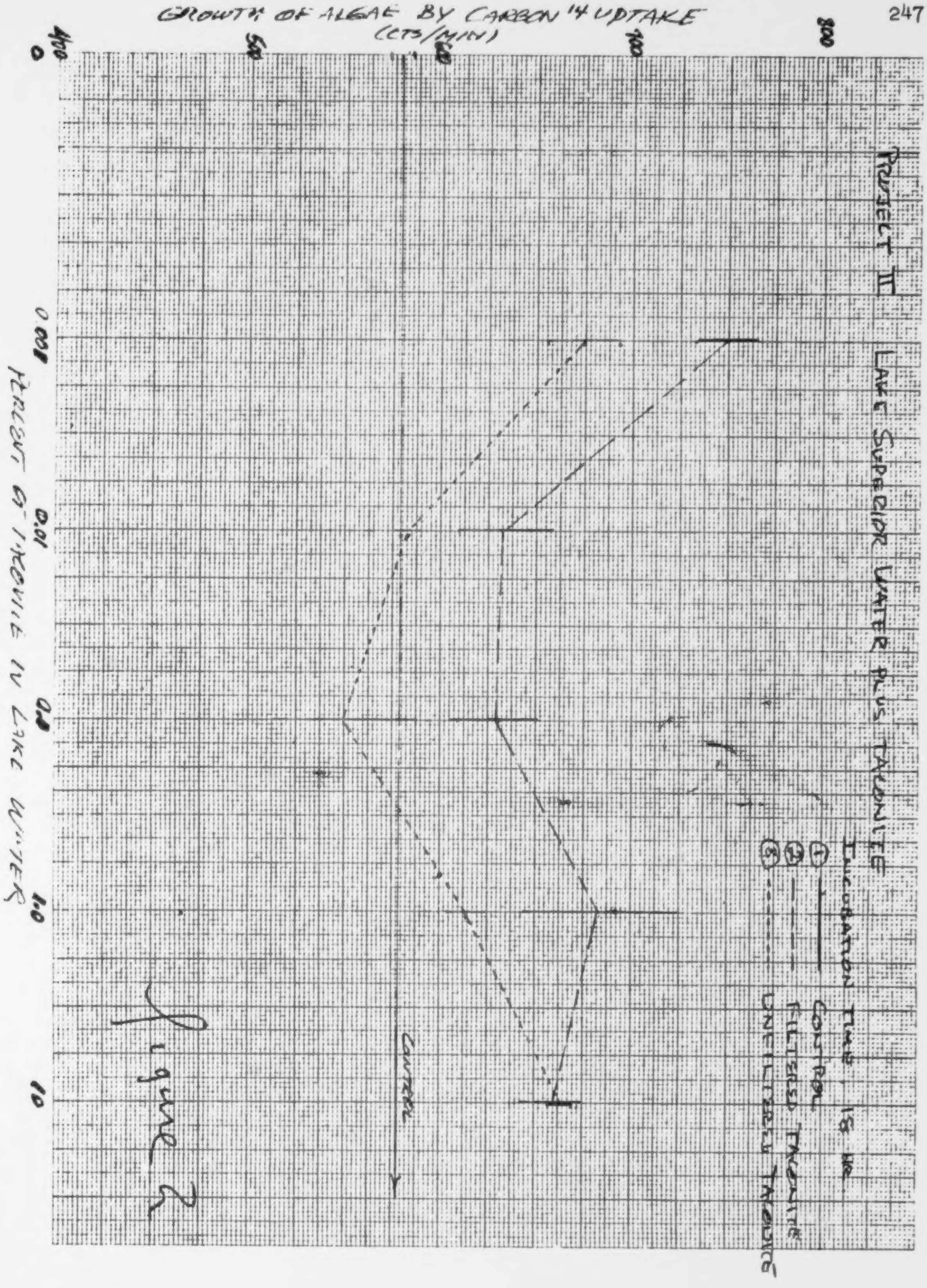

GROWTH OF ALGAE BY CARBON 14 UPTAKE
(CTS/MIN)
0
400
500
600
700
800
PROJECT II LAKE SUPERIOR WATER PLUS TACONITE
INCUBATION TIME 18 HR
① CONTROL
② FILTERED TACONITE
③ UNFILTERED TACONITE
0.001
0.01
0.1
1.0
10
CONTROL
PERCENT OF TACONITE IN LAKE WATER

Figure 2

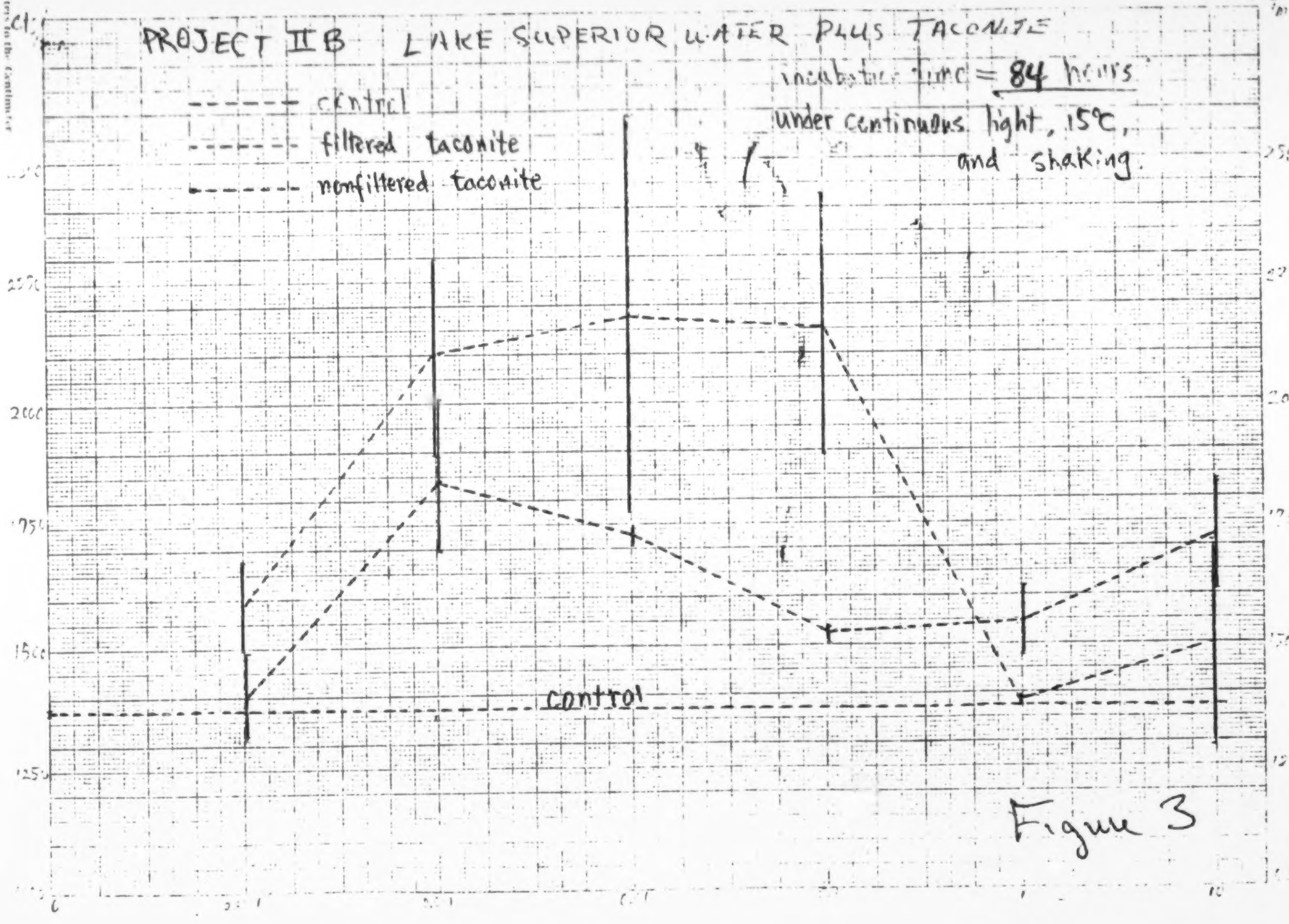

PROJECT II B LAKE SUPERIOR WATER PLUS TACONITE
incubation time = 84 hours
under continuous light, 15°C, and shaking.
control
filtered taconite
nonfiltered taconite
control
Cts.
1250
1500
1750
2000
2250
2500
0
10
10 Millimeters to the Centimeter

Figure 3

MR. FRIEDELL: At this time, the State of Minnesota wishes to introduce Dr. Joseph Shapiro, of the Institute of Limnology at the University of Minnesota.

Dr. Shapiro.

JOSEPH SHAPIRO, PROFESSOR
DEPARTMENT OF GEOLOGY AND DEPARTMENT OF ECOLOGY
ASSOCIATE DIRECTOR, LIMNOLOGICAL RESEARCH CENTER
UNIVERSITY OF MINNESOTA
MINNEAPOLIS, MINNESOTA

MR. SHAPIRO: To expand a little bit, my name is Joseph Shapiro and I am a Professor both in the Department of Geology and Department of Ecology at the University of Minnesota and Associate Director of the Limnological Research Center of the university.

What I want to do is to describe some experiments that I have performed on Lake Superior at the request of the Pollution Control Agency, using samples supplied to me by the Federal Water Quality Laboratory personnel.

These experiments were designed to determine certain facts regarding the status of algae in Lake

Superior to determine what the factors are controlling their growth and to determine if taconite tailings do indeed have any significant relationship to the growth of these algae.

The question of limiting factors is something I should perhaps explain very briefly. Algae as living plants supply a whole host of factors for their growth. These include adequate temperatures, sufficient light, and a whole galaxy of inorganic nutrients. Generally when one speaks of limiting factors or when one attempts to determine the factors limiting the growth of algae, one attempts to determine which of the factors are present in least amount relative to need and, therefore, which factors would have a significant effect upon the algae if added to the water in which the algae are.

Now, the samples, as I say, were supplied to me by the Federal Water Quality Laboratory personnel. These were water samples taken from Lake Superior and two experiments were performed.

The first one concerned samples taken from a relatively inshore station, approximately 10 miles south of Grand Marais, and I attempted to determine on those samples what factors were limiting the growth of algae or conversely what factors if added to the water would stimulate the growth of algae.

The experiments were performed in what is now a routine fashion, so-called enrichment experiment. A sample of water was divided into various portions and to each portion was added a different nutrient substance to determine whether it had a stimulating effect. The nutrient substances chosen were those, I think, which almost any limnologist would select as the ones most likely to be of significance. They included phosphorus, about which we have been hearing a great deal lately in all areas; nitrogen; because the algal population of Lake Superior is primarily diatoms, I tested silica; I tried phosphorus, nitrogen, silica; because I have a particular interest in iron and its relationship with algae, I tested iron; I also tested manganese; and I tested in addition the sum of these things together, "all." And as a control, we used lake water samples to which nothing had been added.

So in other words, then, we set up a series of flasks containing Lake Superior water with its native algae and to these flasks we added individually these substances in physiologically significant quantities, not overabundant, to determine whether they had an effect in stimulating the algae.

The evaluation of the experiments was performed in two ways. One method was a method devised by Dr. Charles Goldman of the University of California at Davis, California, and is the so-called carbon 14 technique. Algae, being plants, require carbon dioxide to grow, and one way to determine the quantity of growth is to determine how much carbon dioxide the plants have taken up.

So in each of these experiments we added a form of carbon dioxide as a bicarbonate, but with the carbon as radioactive carbon, carbon 14. Therefore, in this manner we could follow the growth of the algae as a function of the amount of radioactive carbon the algae took up.

This type of experiment was originally devised for determining the photosynthetic rate of algae and in its original form it was limited to something like two- to eight-hour experiments, because when one is measuring photosynthetic rate of algae, one is interested in an absolute rate, and because when you enclose a sample of water you change its characteristics somewhat, the danger exists that you will run into errors if you run experiments for a long time. On the other hand, in this sort of experiment, an enrichment experiment, it is necessary to keep the algal cultures going for a long enough period to allow the algae to respond to the additions which you have made. So we followed the carbon 14 uptake for a period as long as 10 days.

A second way in which we assayed or evaluated the effect of these additions was by measurements of chlorophyll. Algae being green plants do have chlorophyll in them, and the more algae you have, generally, the more chlorophyll you have. Since Lake Superior has extremely small quantities of algae under normal conditions, the chlorophyll is almost unmeasurable by the normal procedures. Therefore, we used a particularly sensitive technique: we measured the fluorescence of the chlorophyll.

So in setting up these experiments, then, we added individual nutrients to individual flasks of Lake Superior water containing the native algae, the native water, and we monitored the results using carbon 14 and fluorescence of chlorophyll. The algae were maintained at 10 degrees centigrade, which is approximately the temperature of the lake, and they were kept under artificial illumination of about 300-foot candles.

Now, as I say, the experiments were done on two different samples of water or on two occasions, rather. The first experiment was done on two samples taken from near shore, 10 miles south of Grand Marais. Unfortunately, I don't have slides, but the data I have submitted to the conferees, and which I will attempt to draw very briefly here, shows very clearly that of these various substances the only one which stimulates the growth of algae in those inshore samples is phosphorus.

Well, it is very difficult for most of you to see the board, so I will just give you a word picture.

Basically, the control experiment, in which nothing was added, grew along at a leisurely pace, and two control experiments, A and B, grew by exactly the same rate over 10 days, a rather low rate, as measured both by carbon uptake and by chlorophyll measurements. The addition of silica did not change this rate appreciably. The addition of iron did not change the rate appreciably. The addition of manganese had no effect at all. The addition of nitrogen had no effect. Only the phosphorus, a combination of nitrogen and phosphorus, and the experiment I referred to as "all" had any significant effect.

Now the conclusion from that,and [illegible] is a very straightforward conclusion, is that in those [illegible]shore samples phosphorus is limiting to the growth of algae.

The second experiment was done on a sample of water taken from approximately 5 miles offshore at Grand Marais. And the reason that sample was taken differently was in an attempt to characterize the limiting factors in the open water of the lake. In other words, to get away from the shore influence and to look at the offshore water, which in a lake such as Lake Superior represents the vast bulk of the water.

In that experiment we repeated essentially the same thing we had done in Experiment 1. We did not measure chlorophyll consistently because the instrument we were using was being used for other purposes, but we kept carbon 14 records on the samples and we ran the experiment for seven days.

In addition to doing this, we also tried various dilutions of taconite tailings to determine directly whether they had any influence in stimulating the growth of the native algae. We tried concentrations ranging from 1 percent--well, let me back up. We used a slurry of fine taconite tailings which had stood for several weeks, I don't know exactly how long, several weeks to one month. It was a slurry of taconite tailings containing 200 milligrams per liter of particulate material. We used that slurry at a concentration of 1 percent, added it, in other words, as 1 percent of the volume of our experimental flask; we tried it at 1/10th of a percent, at 1/100th of a percent, and at 1/1000th of a percent. In other words, in the lowest concentration of taconite tailings we tried we were working with two parts per billion of taconite solids in Lake Superior water.

Again the data which I have presented to the conferees, and which shows up as a histogram on the last page, well, it shows several things. First of all, it shows that the experiment done on the inshore waters showing that phosphorus was limiting to algae is corroborated with the offshore sample. Phosphorus both at 50 parts per billion and at 10 parts per billion proved to be very stimulatory to the growth of the algae. It also showed something that the inshore sample hadn't showed. It showed that manganese, of all things, manganese is very stimulatory to the growth of algae.

In looking at some data, I must confess just this morning, some data provided by the Canada Center for Inland Waters on concentrations of phosphorus and manganese in offshore waters of Lake Superior, it turns out that the phosphorus values they give are 0.001 milligrams per liter, in other words about one part per billion, the phosphorus is practically not there, so phosphorus stimulation is not surprising. And similarly, the manganese they reported was 0.000. In other words, in most of the offshore water of Lake Superior the Canada Center for Inland Waters detected no manganese, so the stimulation by manganese is not surprising.

On the inshore sample, I would suggest that the lack of manganese stimulation was due to the fact that land runoff may contain sufficient manganese to provide requirements of the algae. But in offshore waters this influence does not seem to be present.

As far as the taconite tailings go, as I say, we tried their effect in concentrations ranging down to as little as two parts per billion,and we found indeed that the taconite tailings by themselves, added to the lake water without anything else, do stimulate the growth of the algae in offshore Lake Superior water. And we also found a striking phenomenon, which I may say is corroborated in the paper of Dr. Charles Goldman which has been presented just a few minutes ago. We found that the lower concentrations of taconite tailings appeared to have a greater stimulatory effect than did the higher concentrations.

Dr. Goldman states in his paper, and I have independently stated at the trial last week that I believe and he believes, that the reason that lower concentrations of taconite are more stimulatory is that taconite possibly contains an inhibitory component, a component which inhibits the growth of algae as well, and that when we dilute the taconite tailings the inhibitory component is diluted at a greater rate. This is not as paradoxical as it sounds, because an inhibitor is likely to be diluted out in a linear fashion, whereas nutrients can be taken out by algae equally as well at extremely low concentrations as it can at high concentrations. So the presumption is scientifically sound.

Now the question about why taconite tailings stimulate the growth of algae. Well, the algae are stimulated in the offshore sample by manganese and by phosphorus. Taconite tailings contain both manganese and phosphorus. Experiments by the Federal Water Quality Laboratory show that if taconite tailings are placed in water they immediately release approximately 15 parts per billion of manganese into solution, solution as defined by filterable through a millepore filter. So that accounts for the manganese.

On the other hand, if you put taconite tailings in water, the equilibrium concentration of phosphorus is about four parts per billion. I believe from my experiments on the effects of phosphate on algae that an equilibrium concentration of four parts per billion is enough to stimulate the growth of algae that are phosphate deficient, and that as the algae use the phosphate more phosphate can dissolve from the taconite.

However, there may be an alternate explanation. When algae are deficient in phosphate they produce an enzyme known as alkaline phosphatase, which enables them to dissolve phosphorus from particulate compounds or to liberate phosphorus from organic compounds which they could ordinarily not use.

We have tested the algae in Lake Superior by a very sensitive technique for the presence of alkaline phosphatase and we have found the enzyme to be present.

Since the particulate matter in the taconite with which I was dealing contained 400 parts per billion of phosphate, it is conceivable to me that the algae either were living on equilibrium phosphate dissolved slowly as the algae used it or were in fact directly utilizing phosphate by means of their alkaline phosphatase.

It is possible to do specific tests for the availability of phosphate. I have not done such tests. The tests I have done are enrichment experiments. On the other hand, I would say that if anyone were to attempt to do studies on the availability of taconite phosphate, then these studies should clearly be done with the utmost caution, should be done in Lake Superior water with algae native to Lake Superior. This is a difficult problem. There are ways to test for availability of phosphate, but most of these ways now utilize blue green algae, for example microcystis. These algae are not native to Lake Superior. And the phosphatase enzymes of algae have been shown to be different. So that I would caution any data on phosphorus availability to be treated with the utmost caution.

One general statement. In sitting in these hearings I've--well, let me be very direct. Mr. Purdy brought up the question as to whether a laboratory experiment can have validity for Lake Superior. I think this was brought up with regard to bacteria. From 20 years of experience as a professional limnologist I would say the answer very definitely is yes. There have been laboratory studies in which the attempt has been made to transfer the results to lake situations and the attempt has been discredited. Without mentioning names, some of these involved people in England, and so on.

On the other hand, science is based on taking a portion of the universe and doing something to it and extrapolating from that to the universe. Medicine is based on this and limnology is no different. There is no point in our attempting to determine whether something has polluted a lake after the material has had a chance to do its work. We are forced to rely on specific experiments done very carefully and extrapolate from those. And in fact the provisional algal assay procedure devised by a joint government-industry task force is based specifically on taking water samples, adding specific effluents to them, and determining what the effect will be on the lake. This is the purpose of those tests.

Well, let me just close with a general summary, then.

I have found in my experiments that in inshore waters of Lake Superior phosphorus alone seems to be a limiting factor in the sense that additions of phosphorus stimulate the growth of algae.

I have found in offshore waters that both phosphorus and manganese can stimulate the growth of algae. I would say with reference to the water quality standards discussed before that perhaps a look should be taken at manganese, which I don't recall being mentioned. Since it does seem to have a stimulatory effect, I would at least urge that it be considered.

Taconite tailings, both in Goldman's work and my work, do stimulate the growth of algae and not necessarily in a linear fashion with regard to concentration. Taconite tailings contain manganese, phosphorus. I cannot say which of these components in the tailings are doing the stimulating. I do believe from my experience it is one or the other.

Thank you.

MR. STEIN: Thank you, Professor Shapiro.

(The data referred to follows:)

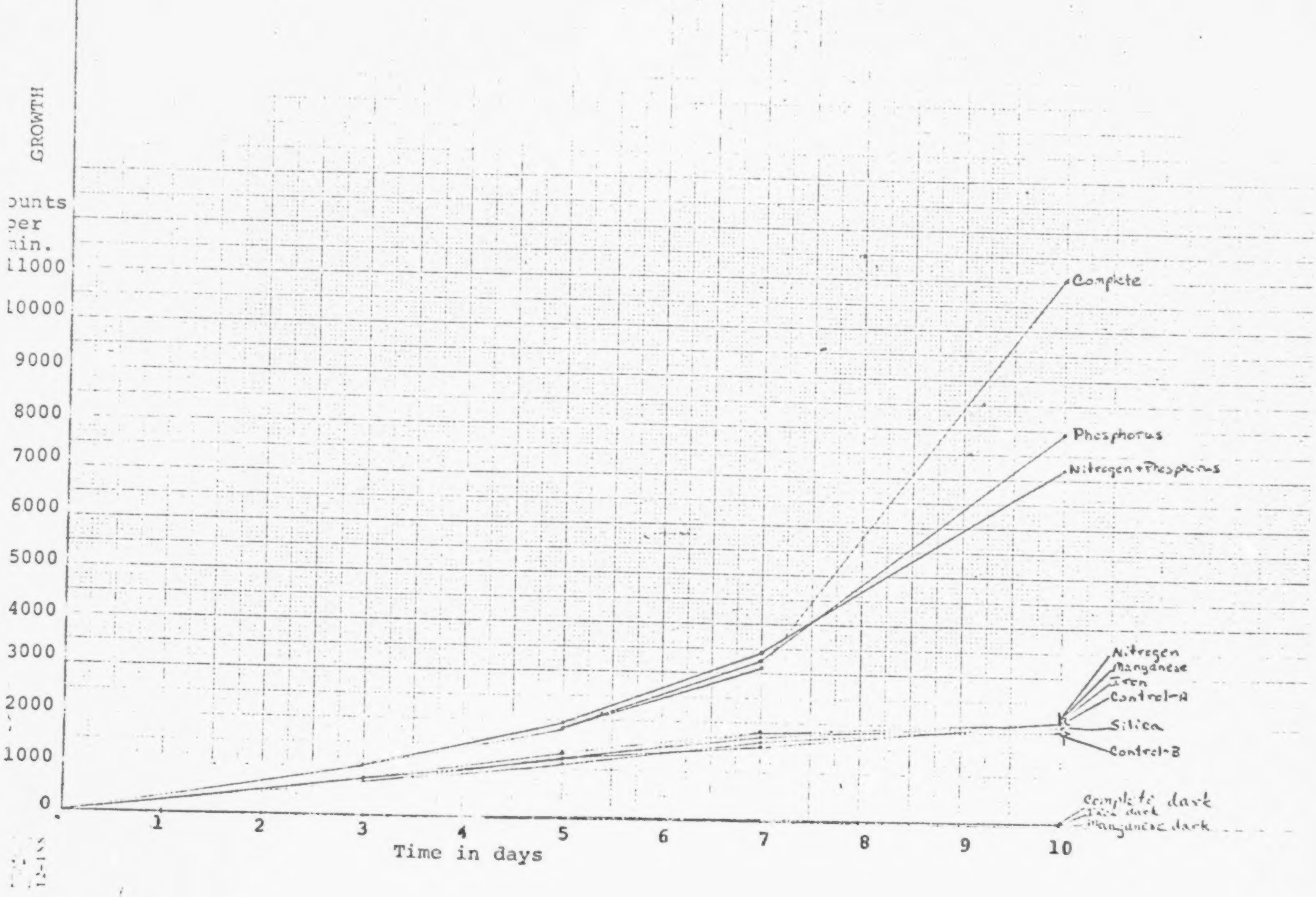
ALGAE GROWTH STUDIES IN LAKE SUPERIOR

by

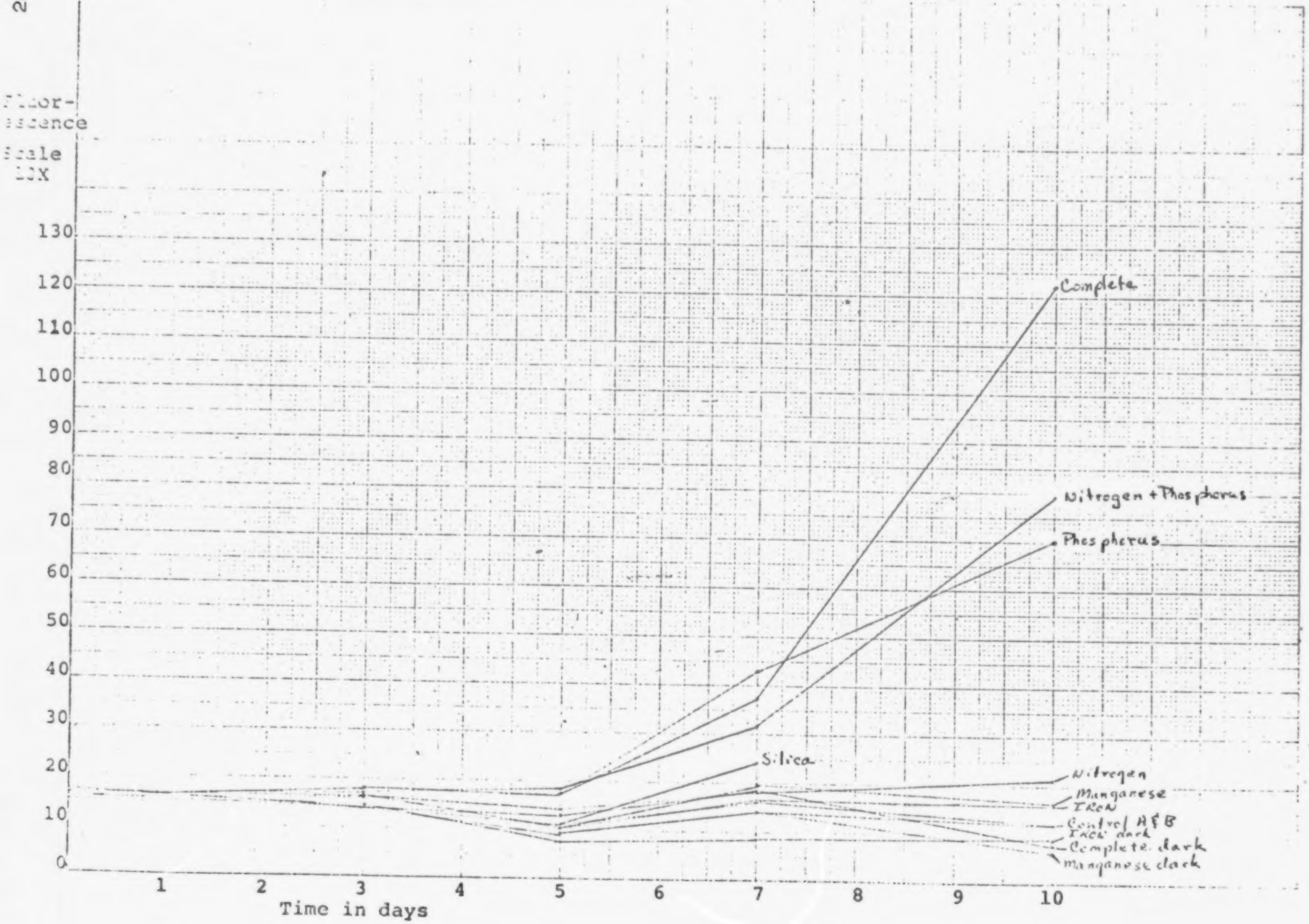
Professor Joseph Shapiro
Associate Director
Limnological Research Center

Limnological Research Center
University of Minnesota
Minneapolis, Minnesota 55455

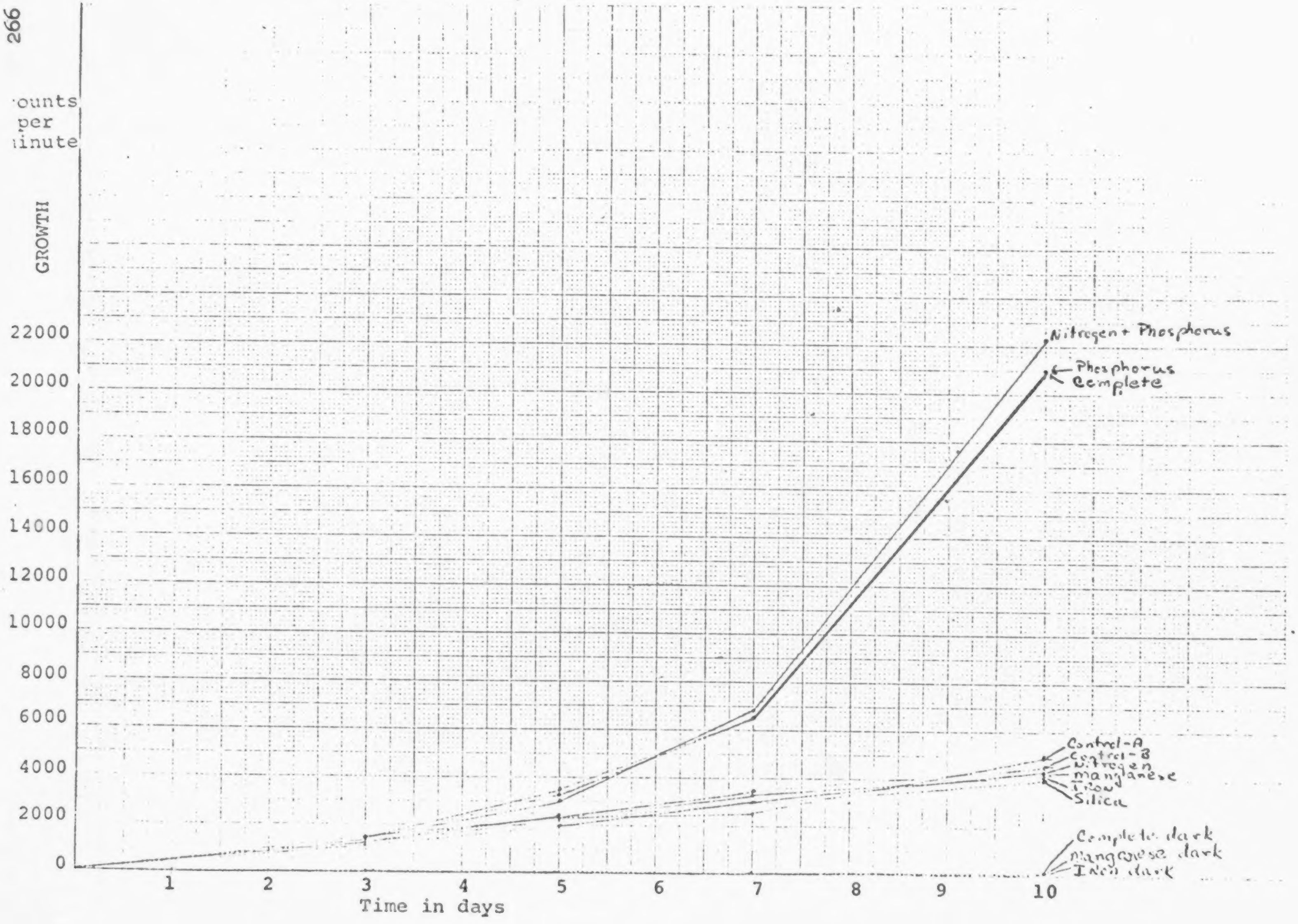
EXPERIMENT #1 Sample #1

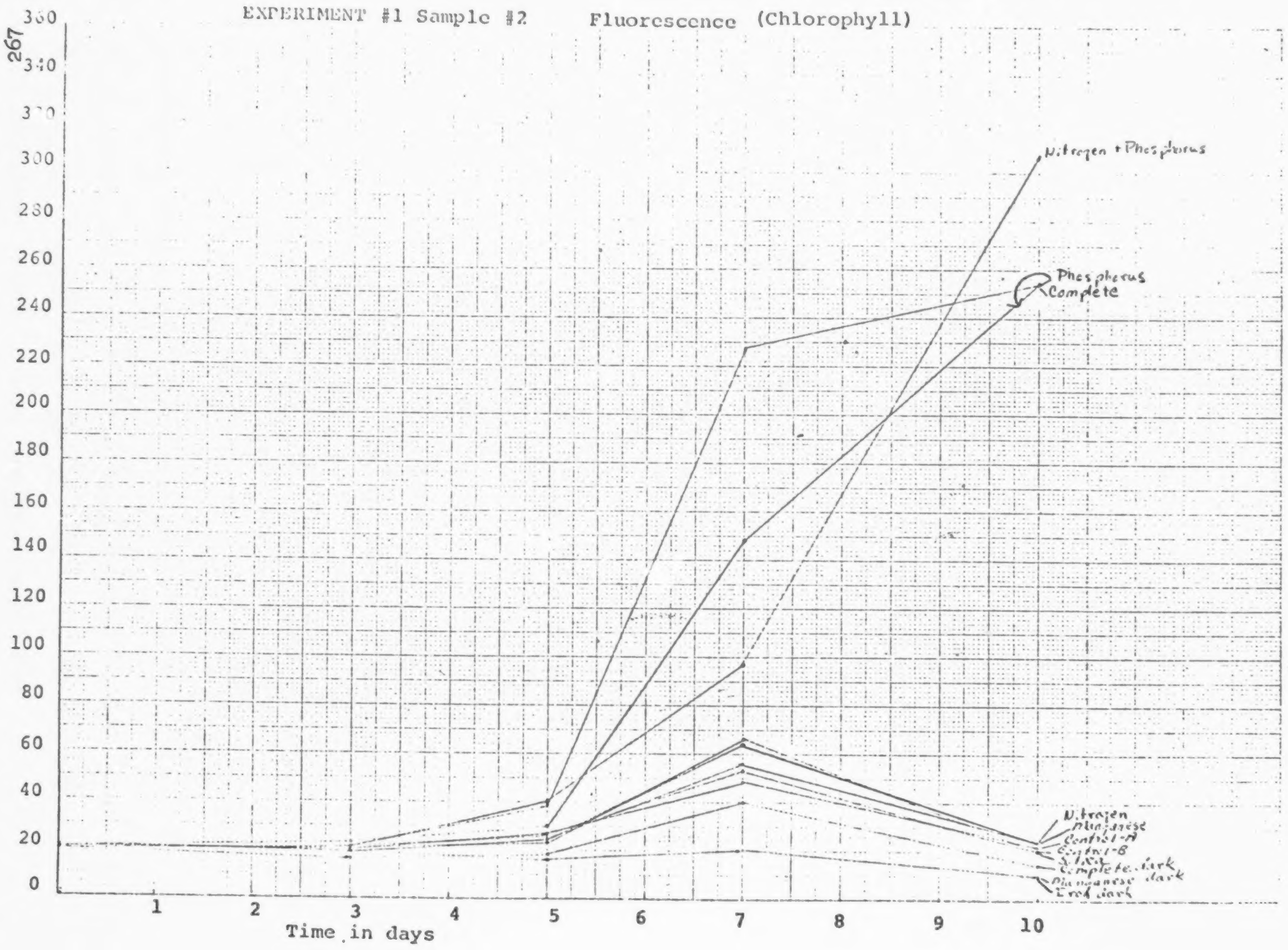


EXPERIMENT #1 Sample #1 Fluorescence (Chlorophyll)

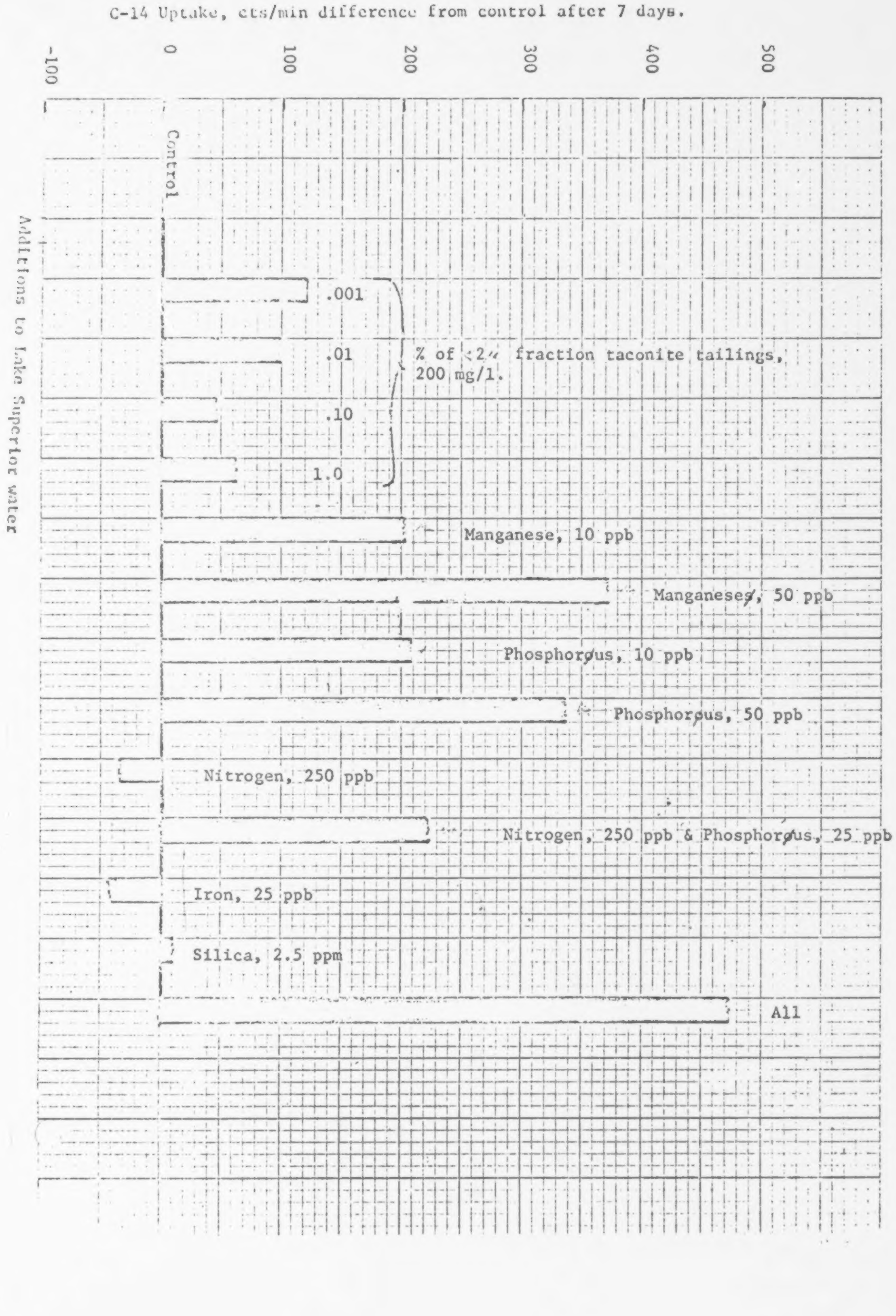


EXPERIMENT #1 Sample #2





EXPERIMENT #1 Sample #2 Fluorescence (Chlorophyll)


C-14 Uptake, cts/min difference from control after 7 days.
-100
0
100
200
300
400
500
Control
.001
.01
.10
1.0
% of <2μ fraction taconite tailings, 200 mg/l.
Manganese, 10 ppb
Manganeses, 50 ppb
Phosphorous, 10 ppb
Phosphorous, 50 ppb
Nitrogen, 250 ppb
Nitrogen, 250 ppb & Phosphorous, 25 ppb
Iron, 25 ppb
Silica, 2.5 ppm
All
Additions to Lake Superior water

MR. STEIN: Are there any comments or questions?

I accept Mr. Friedell's word that you and Professor Goldman are the Gary Player and the Arnold Palmer of your world, and I know what you said about those British experiments or those experiments in England. We will send you everywhere except the British Open. (Laughter.)

MR. SHAPIRO: Thank you very much.

MR. STEIN: Thank you very much.

After this we will call on Dr. Mount. We withheld Dr. Mount until now because we wanted Dr. Shapiro's information and the information of Professor Goldman as well to precede Dr. Mount's statement.

Dr. Mount.

DONALD I. MOUNT, PH. D.

DIRECTOR, NATIONAL WATER QUALITY LABORATORY
FEDERAL WATER QUALITY ADMINISTRATION
U. S. DEPARTMENT OF THE INTERIOR
DULUTH, MINNESOTA

DR. MOUNT: I appreciate, Mr. Chairman, your not commenting about the length of my beard, because it is late in the day again. (Laughter.)

MR. STEIN: You know, compared to the guys we have been recruiting, Don, you look good. (Laughter.)

DR. MOUNT: I wanted to comment last time when you commented about my beard that there is an old Chinese proverb that says if a man is born head first he will be a great thinker and if he is born feet first he will be a great runner. I don't know much about your background, but you certainly make a great chairman.

(Laughter and applause.)

MR. STEIN: That's great. You know, Don, in coming up, the way I heard that story they said that fellows who are bald in the back like I am are great thinkers, guys who are bald in front are great lovers, but people who are bald, like you are, all over thought they were great lovers. (Laughter.)

DR. MOUNT: The record will show that you used that joke the last time. (Laughter.)

MR. STEIN: And they are still laughing.

DR. MOUNT: Courtesy only.

MR. STEIN: Right. (Laughter.)

DR. MOUNT: There are several important considerations which I think must be kept in mind as one assesses the impact of present discharges on Lake Superior.

D. I. Mount

The measurement of small changes in Lake Superior is going to be exceedingly difficult, if not impossible, so it will be imperative to use predictive means whenever possible in order to identify the problems before they become large changes and the damage is inflicted.

We tend to treat Lake Superior as a standing body of water when, in fact, it is as complex of currents in any discharge almost without regard to its size who rapidly become diluted and become an integral part of the lake, so that detection of effects from a given discharge at distances will most probably be impossible in the foreseeable future. This does not mean, however, that any one or more discharges do not have adverse effects and will not cause degradation in the lake. I believe that we must rely primarily on experimental data in order to tell us what discharges in Lake Superior will be because of the difficulty of measuring these small changes in the lake.

We have used bioassays and other tools in the past to assess the impact of discharges on receiving waters and there is no reason why laboratory data properly applied cannot again be used to gain an appreciation of the importance of present discharges to Lake

Superior.

It is also important to emphasize again that the high quality of Lake Superior water must be maintained not only for the continued uses of Lake Superior in this area, but also for the beneficial effect that this high quality water has on the downstream Great Lakes, especially Lake Erie.

The beneficial effect of this high quality dilution water in such lakes as Lake Erie is an invaluable resource which must be preserved. Furthermore, as has been pointed out before, because most concentrations of dissolved materials in Lake Superior are very low, small absolute changes of one part per million, for example, represent large percentage changes in the lake. For this reason, our concern and our monitoring programs must be attuned to sensing and evaluating such small changes.

It is quite obvious that while the assimilative capacity of Lake Superior is extremely large because it is a large lake, it is a somewhat fixed assimilative capacity and once utilized will not be available again for use. The lake has a very slow flushing time. The inflow of water and the outflow is very small in comparison to the size of the lake and materials added to the lake will persist in it for extended periods of time. We believe it will take Lake Erie a long time to recover from its present state, and certainly the time required for Lake Superior to recover from an insult will be many times greater.

As I stated in my summary of the technical findings of this conference, it is the combined opinion of our staff after evaluating all the data available that the important effects of present discharges in Lake Superior are mainly those of nutrient enrichment and that taconite tailings and most other wastes are not directly killing organisms.

My statement, which said in part, "The effect of Reserve's discharge should be evaluated not in terms of toxic effect on fish and fish food organisms nor of endangering water supplies, but, rather, as altering the lake's appearance," apparently was very poorly worded, because it has been taken to mean by most people that I was referring only to the discoloration called green water. This, of course, is one effect of tailings, but my reference to the appearance of the lake referred most importantly to all of the associated changes that take place as lakes age, including the reduction in water clarity from biological growth, the overabundance of algae with the resulting nuisance problems, and the subsequent shift in kinds of fish that are now present in the lake.

Of course these changes are not yet in evidence in Lake Superior, but when the changes can be seen the damage will have been inflicted. Once these persistent materials are added to Lake Superior and become incorporated in it, the removal with present or foreseeable technology will not be possible and they will be there, for all practical purposes, permanently.

Because we have a strong desire to take action immediately, we have erroneously inferred in many instances that phosphorus is the only important nutrient of lakes. Certainly phosphorus is a very important nutrient and is the logical one to control the municipal sewage effluents. However, it would be ridiculous for us to believe that phosphorus is the only nutrient of concern in the lake's aging process. Such reasoning is contrary to accepted principles of nutrition.

I would further point out that the recommendations of this conference call for 80 percent reduction in phosphorus, and so there will still be a significant amount of phosphorus going into Lake Superior even after the controls are applied. Furthermore, there is no reduction at the present time from tributary inputs of phosphorus and these, other than those from municipal sources, controllable sources, coupled with that percentage which is not removed from the sewage effluent will provide a substantial nutrient source of phosphorus for algal growth in the lake.

This makes it imperative, therefore, that all nutrients which are important be controlled if we are going to keep the aging rate of this lake to a minimum. The results of four independent laboratories show that tailings in part per billion concentrations do promote algal growth as do the effluents from sewage treatment plants and other sources.

Repeated tests given at 40 degrees Fahrenheit show that the bacteria, like algae, also are promoted by growth of these types of nutrients. All of these tests clearly indicate that the organisms, both algae and bacteria, respond at levels of taconite in the part per billion range. There has been too great a tendency to assess the impact of a single discharge into Lake Superior rather than to consider the combined effect of them all.

Summarizing the sources of nutrients, certainly prominent among them are tributary inputs. We often feel that everything coming from a tributary is natural when, in fact, this clearly is not the case, because discharge of nutrients from the uses of agricultural fertilizers and disturbance of the soil are other sources of nutrients from the tributaries which are clearly not natural. Among the other sources of nutrients certainly one must mention the importance of municipalities, a source which we expect will be reduced in the future, from shore erosions and upwellings that take place within the lake, industrial discharges, including the wood using industries, mining and other similar activities, and the contribution from rainfall. Many of these sources are beyond the realm of controllability with our present technology and so it is imperative to control every source we possibly can.

In assessing the impact of present discharges to Lake Superior, including Reserve Mining, among many others, I believe that the following facts are now well established and have an important bearing in considering the total impact that may be expected. These facts are:

a) Lake Superior is aging from nutrient input, as are all other lakes.

b) Lake Superior circulates and dissolved solids do move throughout the lake as attested to by the rather homogeneous character of the dissolved materials in the lake water.

c) This conference decided that the lake's beauty was to be protected and the quality of the lake preserved.

d) As Lake Superior ages its present quality will degrade in contradiction to the goals set forth by this conference.

I think that I could not summarize my opinion any better than I did in closing my statement in the April session of this conference when I said:

> "The effects of present discharges are small, but they are in the direction of degradation mostly because the materials being added are persistent and the flushing rate of the lake is very slow. Their effects are irreversible and accumulative. It seems to me, therefore, beyond doubt that all discharges to Lake Superior containing dissolved nutrients

will contribute to the future damage of the ecology in all parts of the lake, and, therefore, these discharges constitute a potential threat to the users of Lake Superior no matter in what State the users may live."

MR. STEIN: Does that complete your statement?

I want to pursue, before I throw this open, one factual thing that just hit me. We agreed on an 80 percent phosphorus reduction program on a Statewide basis, didn't we? The figure I get here is that the phosphorus loading--and when you are talking about phosphorus I will let the scientists talk about this--phosphorus loading to the lake, which we all know deals with the accelerated eutrophication from all sources, municipal and industrial, other than Reserve, is 4,119 pounds a day. If you are going to get an 80 percent reduction you know what they have to do. The figure that I have for total phosphorus from Reserve-- And some of this is bound up in the rocks, I don't know how much is free, but remember the total phosphorus available from all other sources into Lake Superior is 4,119.

This was the critical element we found in Lake Erie and Lake Michigan as involved in the eutrophication process. And check me, Dr. Mount, if I am wrong. Again let me give you that figure: 4,119.

The total phosphorus coming in from the Reserve operation is 51,500. Maybe there is something there when we talk about a reduction in phosphorus. If we are getting all these municipalities to put in their phosphorus reduction and we are ignoring a tremendous source like that, I think maybe we had better look at this program again.

Are there any other questions of Dr. Mount?

Yes, Mr. Purdy.

MR. PURDY: Dr. Mount, I think you have already said it, but so that I don't misunderstand what you have said, I would like to ask you the question--and I think you were here this morning when the chairman listed those specific sets of circumstances that are defined in this matter of endangering the health or welfare, he listed five or six different items.

Now, I am wondering, in your opinion, do you believe that the discharge from Reserve Mining Company is endangering the health or welfare of persons in a State other than the State of Minnesota?

DR. MOUNT: As I attempted to point out in this presentation that I just made, we are dealing with a total system in Lake Superior, in fact one even bigger than that, we are considering Lake Superior, and the contributions which the Reserve discharge makes are not unique. There are many other sources of these and I have identified them. For this reason I believe that the contribution of Reserve and these other discharges in the form of nutrients does constitute an interstate pollution problem.

MR. PURDY: I didn't mean to single out Reserve as being a unique discharger, but I did want to make it clear whether you considered Reserve's discharge to be a part of the total contribution to the lake that endangers the health and welfare of persons other than the State in which the discharge originates?

DR. MOUNT: There is no question in my mind that they are a part of it.

MR. STEIN: I would like to make one more point on the Reserve discharge. And again, Doctor, I would like to refer back to Professor Shapiro's testimony. When he talked about 51,500 pounds of phosphorus, he also mentioned another possible culprit, one or the other, maybe both, manganese. The amount of manganese discharged per day coming from Reserve into Lake Superior--and this again may be bound up, then we have to find out how much is available and when--but the amount coming in each day is 629,000 pounds.

Let me ask you a question, Dr. Mount. Do I understand you to say that because of the nutrients coming into the lake from Reserve's tailings and other sources that we are beginning to see in Lake Superior the kind of accelerated eutrophication problems that we have run into in Lake Erie, Lake Michigan and Lake Ontario?

DR. MOUNT: Well, there have been some who feel that they do see these evidences, Dr. Goldman and Dr. Beaton.

But again what I have said, I tried to say as clearly as I could, and that is that if we see these changes it is too late. We have got to stop this before it happens.

MR. STEIN: You remember what the statute says. The statute says "endanger." Endanger means to put in peril. This is what we are looking for, if it meets that definition of the statute and we are putting this in danger. We know it is too late. We found that out to our dismay in Lake Erie; I hope we can reverse it. We found it to our dismay in Lake Michigan. We found it to our utter dismay in a place you never thought it could happen, Lake Tahoe. And in all of these places people tell us it may be too late. We may be stopping it, but it may be too late.

When they say "endanger", the question here is do you believe that we are in that incipient peril situation where this is a factor that we have to consider?

DR. MOUNT: Well, I would not have been quite so positive about that some months ago, but as we look at these effects of the nutrients in detail, as Dr. Shapiro has reported, we are beginning to see that there are responses to several nutrients in the part per billion range, and by very simple reasoning and calculations one can see that we are contributing these kinds of concentrations to Lake Superior and so, therefore, I think that there is a clear endangerment of the use of this lake and, therefore, I think it falls under the statute, as I see it.

MR. STEIN: Are there any other comments?

I would like to make one other point to you people on the basis of my recent personal experience.

Many of you know that it has been very difficult to reach me to talk to for the last month because I have been given the job of coordinating this national mercury crisis we have. I am finding, place after place, where we get mercury down to counts as small as one part per billion--one part per billion--in the waters and there are buildups of mercury in the muds and in the fish. This is something that we didn't know about and we needed the kind of testing or detection to find it that we couldn't do months ago.

Now, supposing we stop the mercury, as we hopefully are doing, we still have the problem of the mercury in the muds. Once it is in the ecosystem, I am not so sure we are going to be able to get it out because the muds are going to remain and the mercury is converted into forms which fish can absorb. Those fish which do not die may be eaten. We are finding cases all over the country now and are trying to get the mercury discharges stopped.

The question I think we have to face and which we are facing more and more in this pollution operation is that we are grappling with many more sophisticated problems now than possibly the transition stage Ted Wieniewski, Mr. Vogt and I have reached since we first started. We used to deal with these big coliform counts in oxygen sags and thought we were going to get primary treatment somewhere and stop it.

And when I find that we are sitting around with a mercury crisis on the basis of a discharge of a part per billion in many places, it makes me wonder, when we approach a case like this, what the proper view should be. And I would hope again that we will not be faced in Lake Superior with something like we are faced with with the mercury problem; I hope we are not faced with the problem such as we are faced with in Lake Erie, where we don't know whether we can get that lake back again; I hope we are not faced with a problem such as we were faced with in Lake Michigan, where it cost hundreds and hundreds of millions of dollars to turn it around, or in Lake Tahoe, where we have the situation that we can't permit a drop of effluent to go in that lake no matter how well it is treated. We have to get every bit out. Also what we are worrying about now is that little runoff from the fertilization on lawns and on golf courses. That is how critical the balance gets with these small amounts.

Again I think you have a great lake up here, but I would suggest that all of us have to bite the bullet and decide what we are going to do about the problem.

Are there any other comments or questions?

MR. FRANGOS: Yes, Mr. Stein. One, could we have a copy of Dr. Mount's statement?

MR. STEIN: Could you have that, Dr. Mount?

DR. MOUNT: Yes, I will have it typed in the morning.

MR. FRANGOS: In the morning, did you say?

MR. STEIN: No, it will be here in the morning.

MR. FRANGOS: Oh. But was the statement written?

DR. MOUNT: After a fashion it was.

MR. FRANGOS: All right.

MR. STEIN: Will that be all right, Mr. Frangos, or do you need it tonight?

MR. FRANGOS: Oh, no, the morning is fine.

MR. STEIN: We will try to get it, if we can get it within an hour or so, you can have it. If not, we will deliver it as soon as we can.

MR. FRANGOS: All right.

(The above mentioned statement follows:)

SUMMARY OF EFFECTS OF TAILINGS ON LAKE SUPERIOR

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During past sessions of this Enforcement Conference, statements have been made regarding the effects, on the ecology of Lake Superior, of taconite tailings discharged from Reserve Mining Company. The purpose of my presentation today is to attempt to identify important points which the National Water Quality Laboratory feels have been established beyond reasonable doubt. We have been conducting laboratory investigations regarding the chemical and biological behavior of tailings and we completed a sampling survey of Lake Superior bottom sediments last summer. Results of these studies are presented in technical reports that have been sent to each of the conferees in advance of this conference.

During the autumn of 1968, members of my staff studied, in some detail, the characteristics of green water that occurs along the Minnesota shore and is particularly noticeable in autumn and spring. The purpose was to identify the characteristics of green water and the source, if possible. As a result of these field and laboratory investigations, we found that green water contains approximately 1. 5 ppm of suspended solids as opposed to clear water which contained . 5 or less ppm of suspended solids. Attendant with this increase of suspended solids concentration is a reduction in light penetration by as much as 5 to 10 times. Divers report that when viewed at night using a flashlight beam, particles are visible in the green water in much the same way that dust particles can be observed in a sunbeam passing through dusty air. On some days, bands of green water extended in a continuous fashion from the Reserve discharge to many miles southwest of the plant, and there was no doubt in the minds of the divers observing the green water bands, that the source was Reserve Mining.

To provide objective data substantiating this observation, detailed analyses of the suspended solids were completed to identify the same, using the presence of cummingtonite, and the absence of clay minerals as indicators. The results established beyond reasonable doubt that these bands of green water were due to tailings suspended in the water.

Figure 1 shows the characteristic X ray diffraction patterns of the suspended solids in green water and of effluent from the plant.

Normal clay minerals are absent and the patterns are identical for both samples, suggesting a common source. Figure 2 shows characteristic X ray diffraction patterns for sediments from two tributaries to Lake Superior. Note the near absence of cummingtonite and the presence of normally found clay minerals. Other laboratory studies of the reflectance spectra of suspended tailings from green water indicated that the color would appear as yellow-green to the eye.

Green water masses sampled along the Wisconsin shore and caused by heavy rainfall and subsequent runoff, contained only a trace of cummingtonite but the normal clay minerals that are found in natural sediments were present. Since these analyses did not reveal the presence of tailings in green water masses along the Wisconsin shore, the results added confidence that the method of identifying tailings in Lake Superior water by the use of cummingtonite, is a valid one.

Other data were presented in the May session of this Enforcement Conference and established the presence of cummingtonite in the water supplies of several municipalities along the Minnesota shore. The significance of these findings is not that there is an adverse effect on water supplies, but that the per cent of tailings in the sediment of the water supplies decreased with distance from the Reserve plant, indicative that the source was from that discharge. Furthermore, sediment collected from the detention basin at the Duluth Lakewood Pumping Station in 1962 was negative for cummingtonite and therefore not tailings, but sediments obtained in 1969 were positive for tailings. These observations lend strong evidence that the source of the tailings could not have been from the insignificant use of them on the highway for ice control and highway fill.

Some were not convinced that the method was valid, so a core sampling program was developed to establish whether or not there were natural sources of cummingtonite in other parts of the Lake that might confuse identification of tailings. Undistrubed core samples were taken with conventional core sampling devices, quick frozen aboard the vessel, and brought to the laboratory for analysis. Sections of these cores were made and the measurements of cummingtonite and therefore tailings, were quantitative. The detailed results and statistical evaluations are presented in the technical report supplied to you. Traces of cummingtonite in tributaries had been found and reported previously, so it was necessary to quantify the amount present and contributed from natural sources. The bottom portions of the cores had the same per cent cummingtonite as the natural stream sediments from tributaries in Wisconsin and Minnesota. This established that the input of trace amounts of cummingtonite from tributaries has not changed for a long period of time and that our estimates of these trace amounts contained in stream sediment, are representative. Knowing the true amount of cummingtonite from natural sources, enabled us to positively distinguish the input from Reserve even though very minor amounts are found in stream sediment. The cummingtonite content of the upper layers of some cores is much higher, indicative of a more recent and new source of that mineral. Cores taken "down current" from the Reserve discharge and near the plant show as much as 30% cummingtonite (or as much as 75% tailings). The statistical analysis performed revealed that 7 of 14 cores from the Wisconsin side of the Lake contained tailings in the upper layers of the core. The per cent of tailings in lake sediment is low and deposition is discontinuous over the area southwest of the Apostle Islands. Tailings are mixed with the surface layers of sediment and are not as a blanket over the lake bottom. Figure 3 shows the relationship between depth of tailings within the core and depth of water, for a transect from Encampment Island to Herbster, Wisconsin. One can see that the tailings are being deposited primarily in the deep trough off the Minnesota shore and that on this transect no tailings were found in the Wisconsin portion of the Lake. Figure 4 shows a similar plot for a transect extending from Stoney Point to the Brule River. One can see that the tailings are deposited over a broad area of the Lake and in Wisconsin. This pattern may be caused by lake currents carrying suspended tailings out of the trough into more shallow water, forcing them to spread. This suggests a reason Wisconsin samples on the Encampment Island-Herbster transect, were negative. The obvious stratification of cummingtonite in the core establishes beyond reasonable doubt that the source is a recent one. In conjunction with the other data, this clearly identifies the source of cummingtonite as tailings, and demonstrates movement into a state other than that one in which the discharge originates.

Another investigation completed during the past winter at the National Water Quality Laboratory, was one to measure the direct toxic effects of taconite tailings on lake animals. For these tests, we utilized the liquid portion of the effluent and only the less than 2 micron tailings. This decision was made because we do not expect the coarser particles to be carried great distances in Lake Superior. The results of these tests have been presented in a technical report also.

Concentrations less than 10% (equivalent to 20 ppm of suspended solids), had no direct effects on the eggs of brook trout, lake trout or lake herring, nor were there significant effects on the reproduction of important plankton organisms such as *Daphnia*. The data for *Mysis* and *Pontoporia* are inconclusive, but suggestive that there may have been effects at lesser concentrations. Mortality in control tanks was higher than is normally acceptable for bioassays of this type, and so no significance can be attributed to these mortalities of these two invertebrates. Bioassay data clearly suggest that direct adverse effects of the tailings on fishes and fish food organisms will not occur at the concentrations expected in the Lake, except for local areas near the discharge and in the heavy density current.

Other tests were performed utilizing Lake Superior plankton to determine whether or not there is algal growth potential from the effluent. The results of these growth tests utilizing Lake Superior algae, at prevailing summer, surface temperatures, reveal that at 10% effluent (equivalent to 20 ppm suspended solids), there are slight growth promotion effects of the effluent as shown in Figure 5. These are not large, but do suggest that there is some nutrient value in the tailings and that a sufficient concentration produces a measurable increase in algal growth. These data do not suggest that there will be an algae bloom near the point of discharge, but indicate that materials are dissolving that provide nutrients for algal growth and that the tailings therefore should be considered as one source of nutrients in Lake Superior.

Still other tests were performed to determine the effect on the growth of bacteria of sanitary significance. *E. coli*, one of the most commonly used indicator bacteria and *Klebsiella pneumonia*, a human pathogen, were used as representative bacteria for the tests. Figure 6 shows the response of *E. coli* to tailings. One-tenth per cent effluent in Lake Superior water (equivalent to approximately .2 mg/l of suspended solids), compared to 100% lake water caused a significant decrease in the die away rate of *E. coli*, and 1% produced a luxurient growth of bacteria. Figure 7 shows the response of *Klebsiella* to taconite tailings and in this case, there was no response at .1%, but a significant response at 1% (equivalent to 2 mg/l). These tests suggest strongly that bacteria discharged into the Lake will live longer or even grow, in the presence of tailings. Most importantly however, these tests demonstrate that the tailings are biologically active and that they are **not** inert. At the present time, known discharges of bacteria to Lake Superior are not numerous and the number should be reduced when adequate treatment is provided. There is no implication from this data that we should expect to see a bacterial problem in Lake Superior if discharges containing bacteria are adequately controlled.

Solubility studies were also made to establish the rate of solution of tailings in Lake Superior water. Some solubility studies were performed at summer temperatures in order to accelerate the rate of solution and to compress the experimental period into a shorter time span. The results of some of these studies are presented in Figure 8. You can see a rapid increase in dissolved materials as the water passes through the plant and a much slower rate of solution during the next 28 days. Various dissolved solids increased from 1.5 to 18 times over those in lake water. Figure 9 shows the increase in conductance of the water in contact with tailings. During a period of 90 days, conductance, an indicator of total dissolved solids, increased from 30 to 70%, depending on the suspended solids concentration. Other tests measured solubility of total tailings effluent, in 5-gal. carboys at 6° C (a typical lake temperature for the bottom of the Lake), for a period of 332 days. These provided a more realistic picture of the solubility rate that might be expected from tailings settled on the Lake bottom. This experiment was unrealistic in that there were no water currents in the jugs to mix the dissolved material. These data show increases up to 100% in the dissolved silica, sodium, potassium, calcium and magnesium, indicating that even in the absence of currents and when settled on the bottom, the tailings do dissolve slowly. Increases of dissolved solids in interstitial water were much larger.

Since Reserve reported preliminary data on bottom fauna studies in May, we did not conduct additional sampling surveys in the Lake, but we look forward, with great interest, to hearing at this conference the results of those studies.

Unfortunately, it was not possible to conduct the experimental work designed to determine whether or not important fishes in the Lake, such as lake herring, avoid green water. These studies would have been helpful in assessing the significance of green water along the Minnesota shore and in verifying the alleged effects on commercial fishing.

The data presented do not clearly reveal the impact of tailings on Lake Superior. I have had numerous discussions with my staff regarding the probable impact of tailings on Lake Superior, viewed in light of the data currently available. We are fully aware of the serious consequences of failing to adequately protect Lake Superior from man made discharges and we are also keenly aware of the expensive disposal methods which would have to be employed in order to eliminate this discharge. With these important considerations in mind, and in light of the scientific data presently available, we believe that the following points are established beyond reasonable doubt:

1. Tailings discharged to Lake Superior by Reserve Mining are found in the western end of Lake Superior and occur in the sediments of Wisconsin. These deposits are discontinuous and are mixed with the surface layers of the bottom sediment of the Lake. There is not a blanket over the western portion of the Lake, except for an area near the point of discharge.

2. Tailings cause green water along the Minnesota shore, and there is an adverse public reaction to the aesthetic appearance of this coloration.

3. The tailings contribute measurable quantities of dissolved materials to the Lake. Based on data supplied to the State of Minnesota by Reserve, this is a minimum of 20 tons per day. These materials provide measurable algal growth stimulation when in sufficient concentration, indicative of their nutrient value.

4. Tailings are biologically active as evidenced by effects on algae and bacterial growth.

5. With the data available to date, it does not seem probable that there are direct adverse effects on the fishes of Lake Superior, or their food organisms, except near the discharge.

6. The bacterial and algal growth promotion and the contribution of dissolved solids from the tailings contribute in an adverse way to water quality.

7. Many materials contributed to Lake Superior water by the taconite discharge are contained in other discharges identified by this conference and the control of the Reserve Mining discharge should be considered as one part of the basin-wide problem.

These effects must be put into perspective and balanced against still other considerations. Of all uses, regulatory agencies most often regard effects of pollutants on aquatic life as the most pronounced, but this is not true in Lake Superior. This conference stated that Lake Superior is a "priceless natural heritage" and that it is "to be preserved in its present state." To achieve these goals, every effort must be made to remove all possible sources of materials entering the Lake. Data have been presented to this conference before demonstrating that an increase from .5 to 1.5 ppm of suspended solids will reduce water clarity by several fold. This is a change not worth considering in most lakes; neither are such changes likely to drastically alter the fishery of Lake Superior. But, they will cause an obvious and undesirable change in the Lake's blue color, aesthetic appeal, and water clarity.

In my judgment the effect of Reserve's discharge should be assessed in terms of altering the Lake's appearance rather than the toxic effects on fish and fish food organisms, or endangering water supplies. The discharge is one of many sources increasing the dissolved materials in the water and these materials provide some acceleration of the Lake's aging process. Certainly the population and industrialization will increase in the basin and this growth will place an increased burden on Lake Superior. The decisions made now regarding the addition of persistent materials will affect the entire history of Lake Superior.

As sanitary engineers and regulatory administrators, we have fooled ourselves, and unthinkingly implied that secondary waste treatment of sewage will give a high quality effluent, but this effluent still contains high (relative to Lake Superior) concentrations of dissolved solids that also contribute to aging. The concentrations of sulphates, chlorides, calcium, sodium, nitrates and others, are much higher in secondary effluent than present concentrations in Lake Superior, and these sources, combined with ones from mining, paper manufacturing and clay erosion, will accelerate the increase in total dissolved solids and eventual eutrophication. We won't stop eutrophication, but we can reduce the rate.

Many say Lake Superior is too big to contaminate. As a boy in Ohio I heard this said of Lake Erie, too, but now we know differently. I, for one, have been skeptical of the alleged effects of pesticides on fish and birds, but I must confess my mind has been changed by environmental recovery following the ban of DDT and dieldrin in Great Britain. Who of us here today would have believed, five years ago, that a few parts per trillion of DDT in Lake Michigan would result in seizure of coho salmon by FDA because the DDT concentrations in the flesh were unacceptably high? Who of us here would have predcted two years ago, that the very small discharges of mercury into Lake St. Clair and Lake Erie would result in closing the commercial fishery of Lake Erie, in order to guard against human consumption of fish containing an unacceptable amount of mercury?

Some here today, believe that the present discharges to Lake Superior will not cause adverse changes in the Lake. What are the chances that an effect like the DDT effect in Lake Michigan will happen in Lake Superior, perhaps for a different pollutant? How many realized that the Welland Canal around Niagra Falls would result in the near loss of the lake trout fishery of Lake Superior, as a result of the lamprey?

We must consider Lake Superior as part of the Great Lakes and not isolated from them. Of course Lake Superior will not be affected by many events in the other Great Lakes, but events in Lake Superior will certainly affect them. The high quality water from Lake Superior must have a tremendous beneficial effect on Lake Erie and clearly nothing should be done to reduce that benefit.

In summary, I suppose the essence of what I have tried to say is that the effects of present discharges are small, but they are in the direction of degradation, mostly because the materials being added are persistent and the flushing rate of the Lake is very slow. Their effects are irreversible and cumulative. The decision is, in reality, based on the question, should our plan of action protect for 50 years, or 500 years, or more? Historians may well record that the future of Lake Superior was cast by this conference. The conferees' responsibility is sobering.

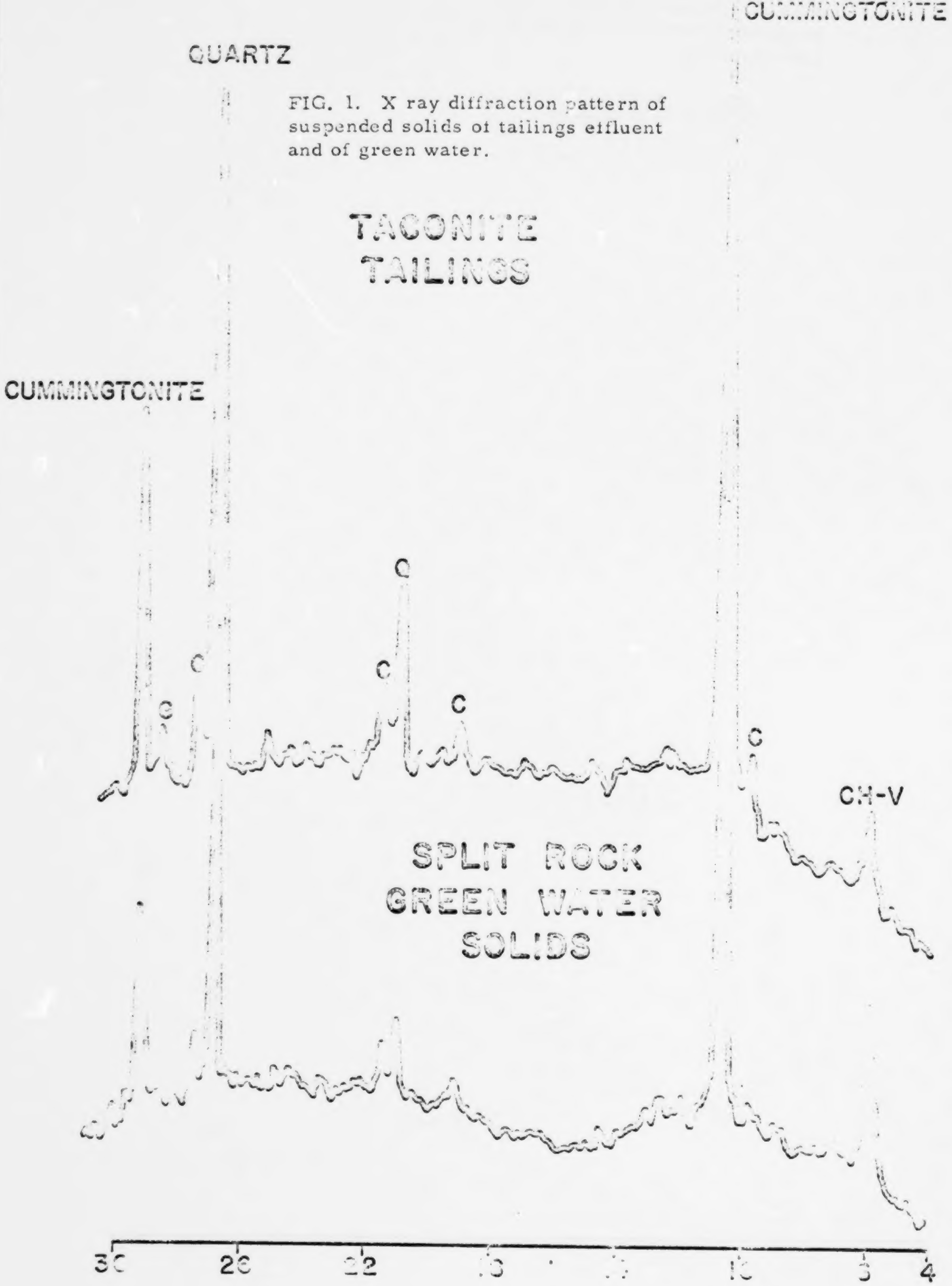
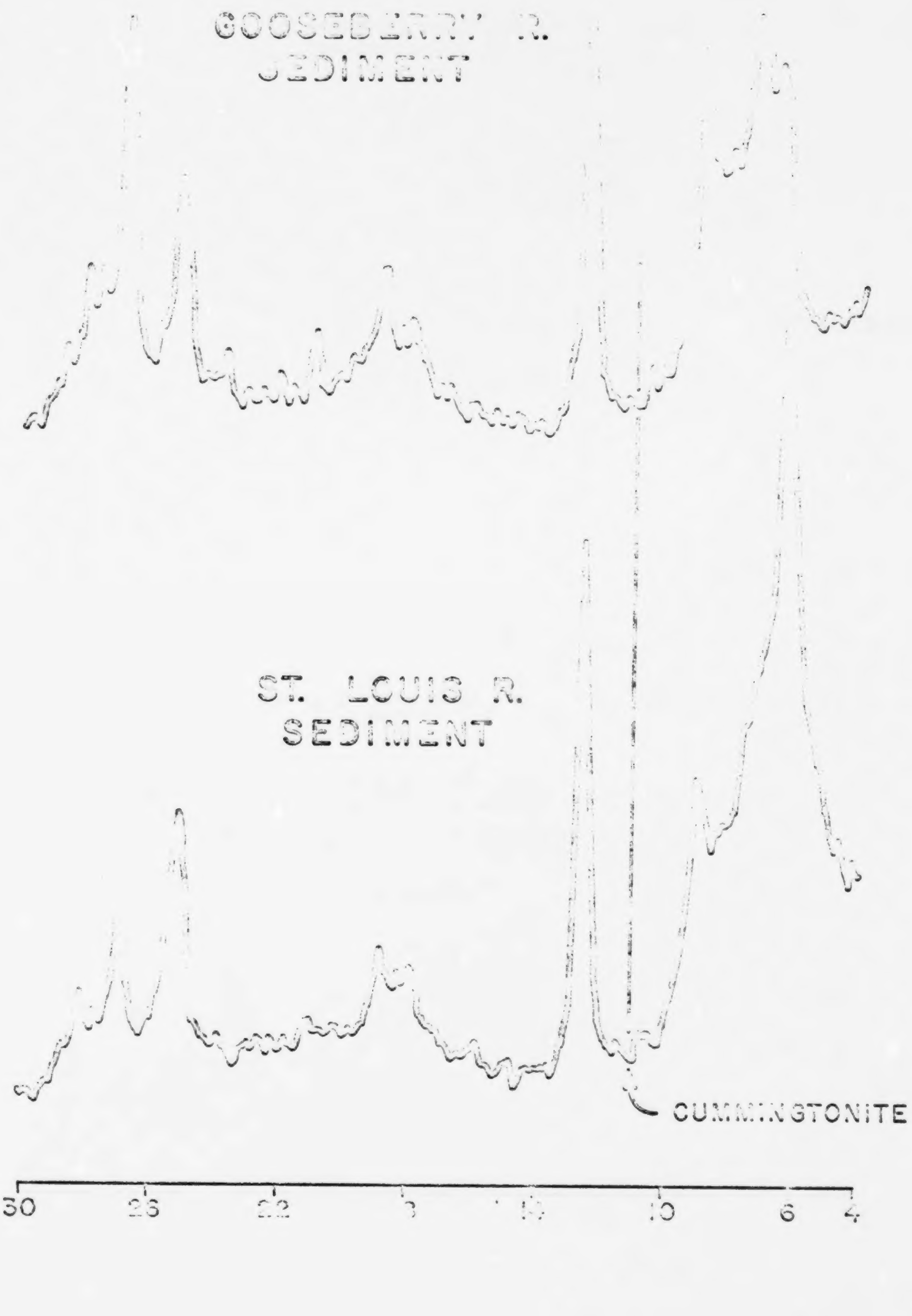


FIG. 1. X ray diffraction pattern of suspended solids of tailings effluent and of green water.

FIG. 2. X ray diffraction patterns of suspended solids from tributaries to Lake Superior.



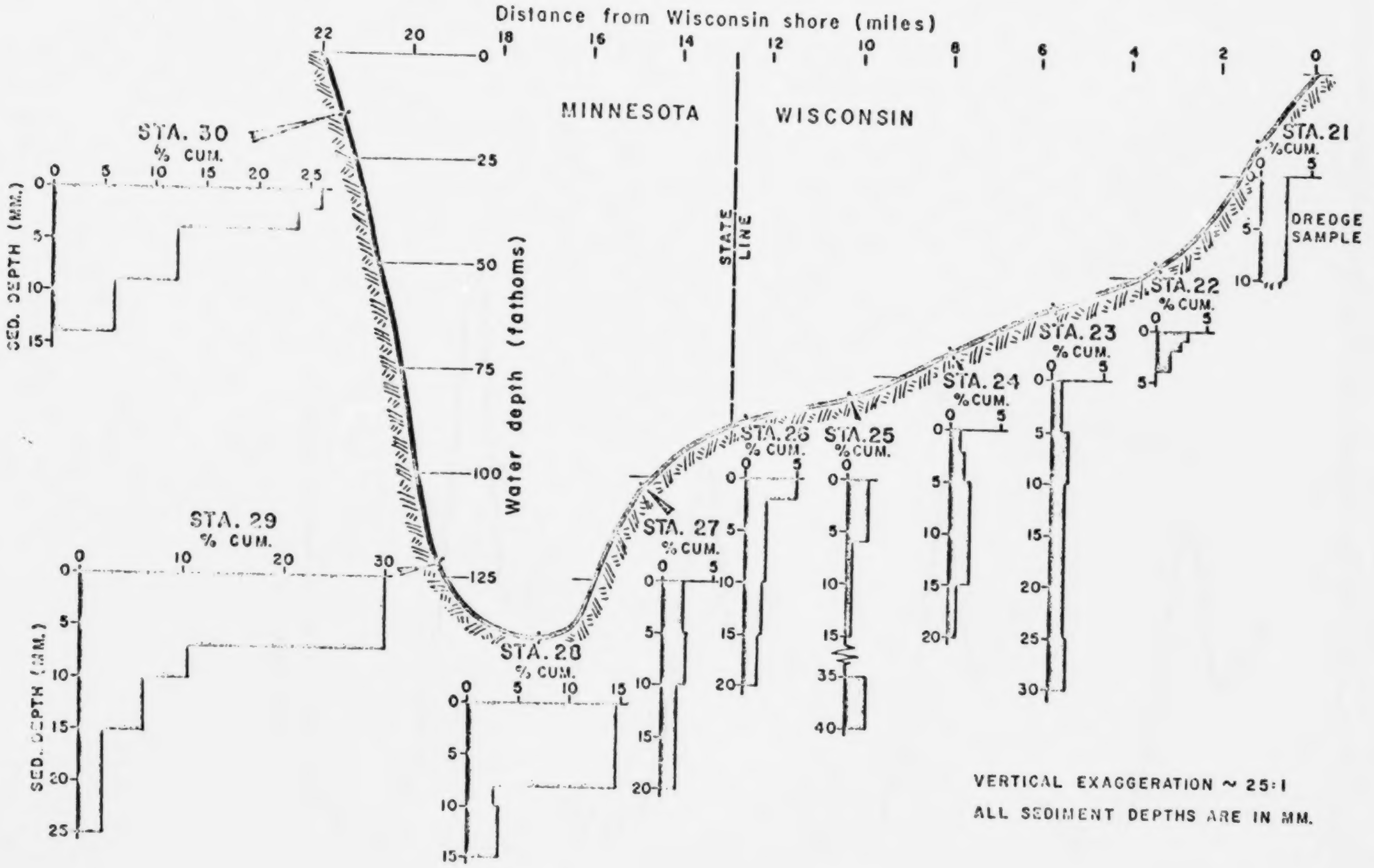


FIGURE 3. ENCAMPMENT ISLAND TO HERBSTER WIS. TRANSECT SHOWING THE RELATIONSHIP OF % CUMMINGTONITE TO SEDIMENT DEPTH IN CORE SAMPLES.

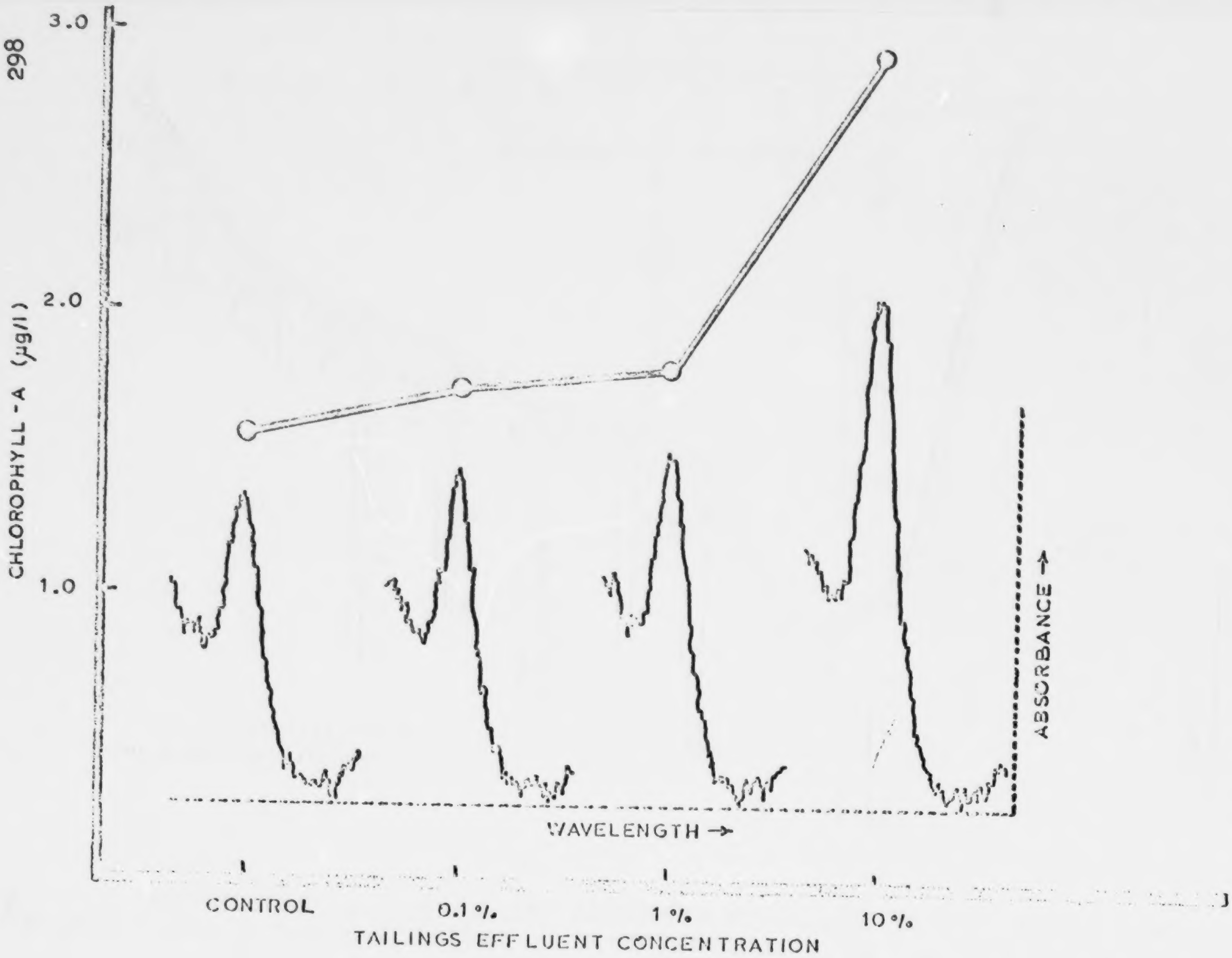


FIG. 5. Chlorophyll-a content and spectra (6630 Å region) versus taconite tailings effluent concentration.

FIG. 6. Growth response of *E. coli* to tailings.

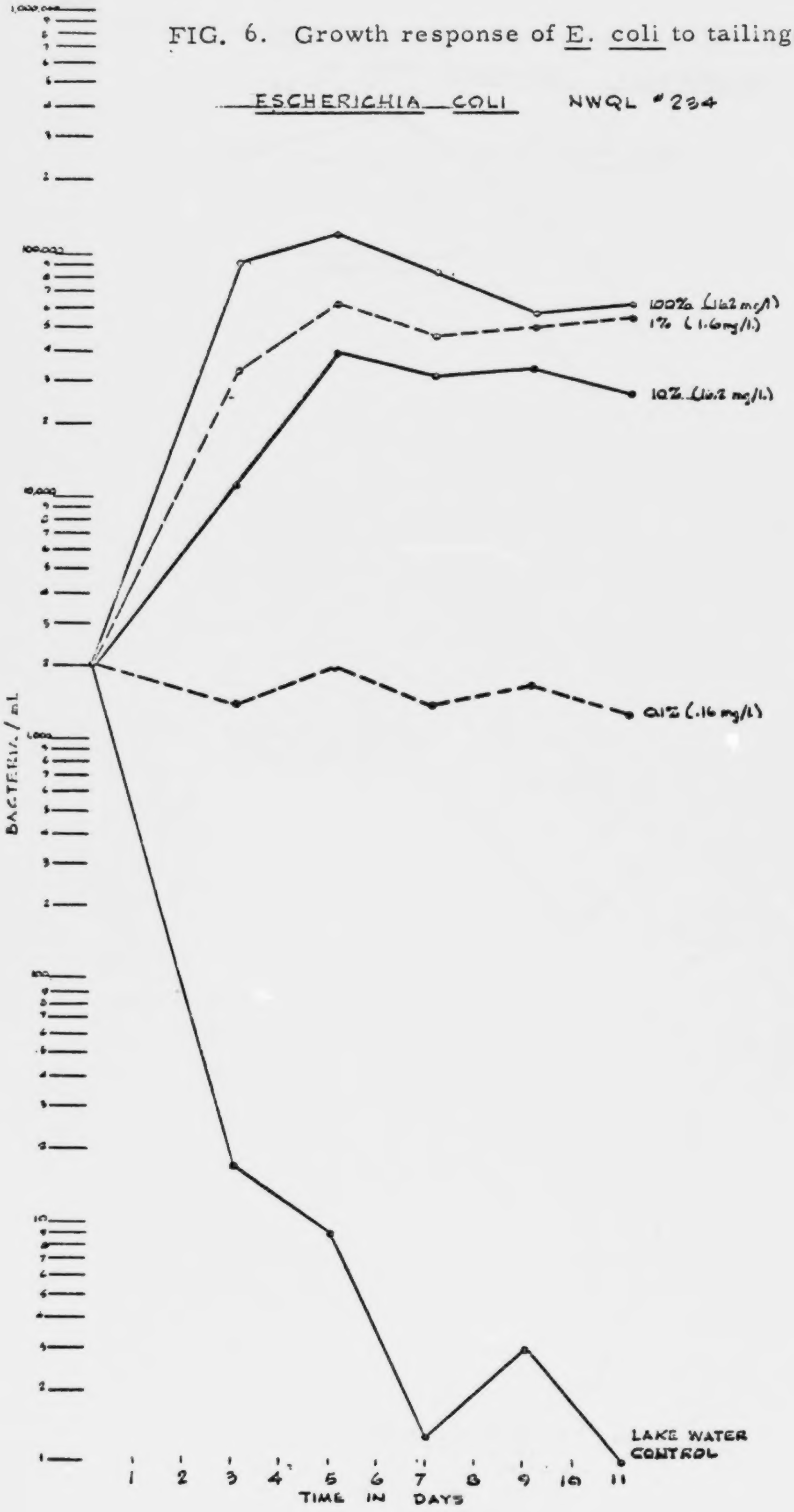


FIG. 7. Growth response of K. pneumonia to tailings.

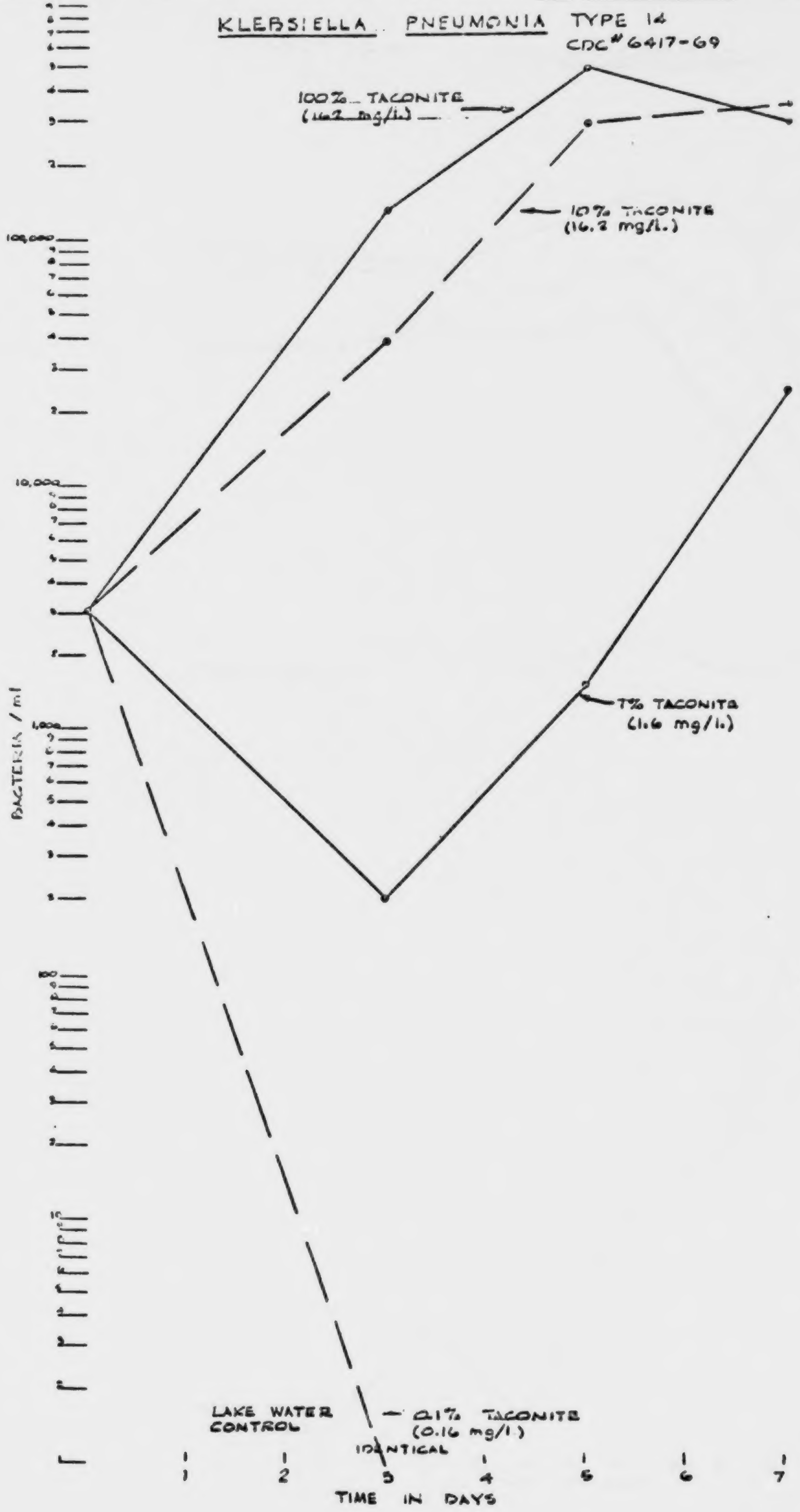
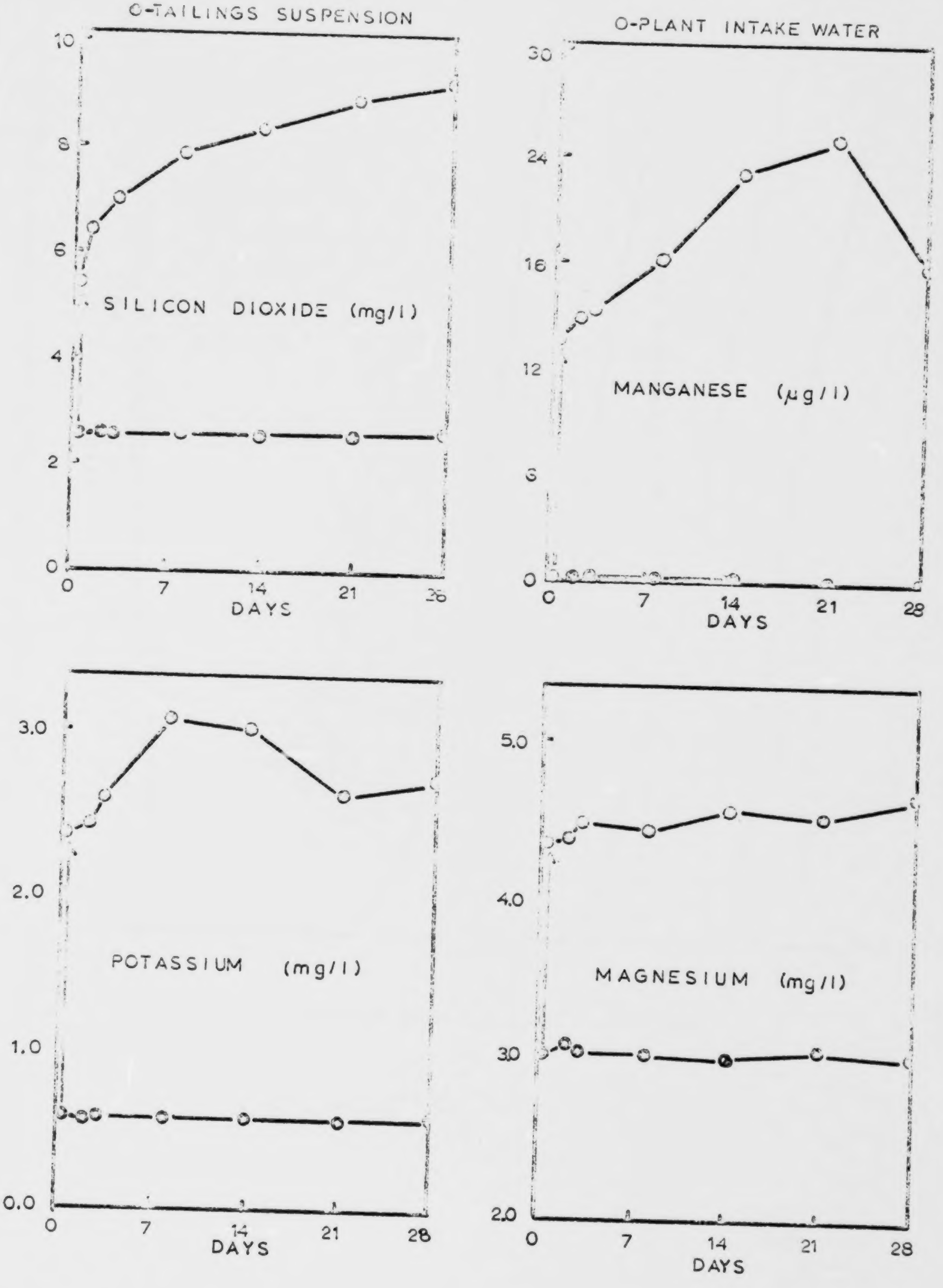


FIG. 8 Chemical analyses of taconite tailings effluent versus days at 6° C.



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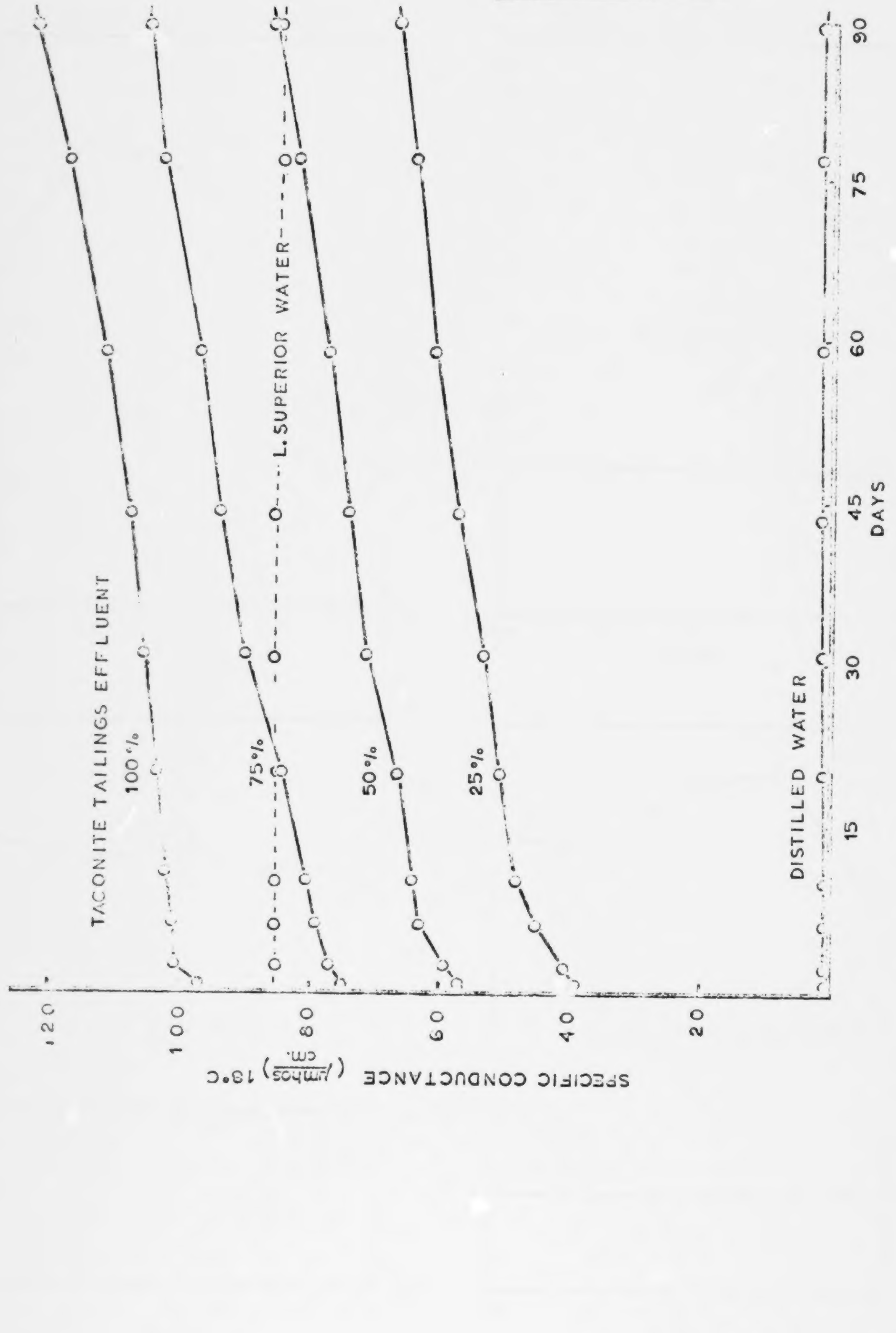


FIG. 9. Specific conductance of taconite tailings effluent versus days at 20° C.

I have a couple of questions. Again we are talking about that word "endanger" and you may find a number of definitions, depending upon where you look for it, but at least in my thinking it does connotate some kind of a time frame, that there is some kind of imminence involved in this phrase "endanger."

The question that I have of Dr. Mount is, do you view this endangerment at least partly out of the fact that we don't have all the answers to the questions that we have raised here on this lake?

DR. MOUNT: No, I don't think that I do in this case, because as the chairman has indicated, we have been over this road in several lakes already. We know, first of all, that there is a rate of aging which is beyond our control, and so we are really in every case with the lake trying to keep that rate down as low as we can and make its life as long as we can. We have to view the input of these persistent materials into any lake, including Lake Superior, as being irreversible and shortening the lake's life by whatever amount this rate is increased. And there is no return on this. I mean you can't go back, really.

And so this, coupled with the fact that the tributary input to the watershed of Lake Superior is very small, I think there is no question that taking all of these sources together we have a very significant contribution to the lake and one that is going to produce changes in this lake in our lifetimes. As I say, there are some who feel they see the evidences already. Dr. Goldman pointed this out in his paper, that in Lake Tahoe the growth of algae on the rocks along the shore was the first indication that there was trouble coming, and I have seen that all along the shore of Lake Superior and I am sure that you people have, too, if you have looked. I don't know how long that has been there, but it is one of the early signals that forecasted trouble in Tahoe and we see them here.

MR. FRANGOS: All right. So I gather that certainly when you are talking about endangering, prudence is one of the things that we think about.

DR. MOUNT: Yes.

MR. FRANGOS: Just let me take you to this interstate business. We are talking about health and we are talking about welfare. Am I correct to conclude that you tag this onto the possibility that we are endangering the welfare of people in States other than in the State of Minnesota rather than health?

DR. MOUNT: I think this is the first effect that we usually see in any pollution situation as it grows worse. The first effects are perhaps not on health, but these eventually come. I think we are beginning to border on this in Lake Erie--well, we clearly are in Lake Erie, without a doubt, bordering on the health aspect, so it is just another stage in the whole process.

MR. FRANGOS: All right. But as you see it, as you assess the situation, it is the welfare of citizens in other than the originating State that are being affected?

DR. MOUNT: Yes.

MR. FRANGOS: And then this welfare is the fact that there is a potential for eutrophication of Lake Superior?

DR. MOUNT: Yes, and bringing with it all of of the changes which we know do take place, including a complete change in the aquatic life, eventually.

MR. FRANGOS: Again, other than the eutrophication potential here, out of all your studies that you have made on the lake, are there any other potential situations that you see that might go into that welfare package that is endangered, other than eutrophication?

DR. MOUNT: Well, I think that the increase of suspended solids, from whatever source it may be, poses a more severe water treatment problem. We certainly have abundant experience, not I but others in the Agency have abundant experience to show that the effectiveness of chlorination is reduced as the suspended solids are increased, or any other particulate matter, for that matter. And so this, perhaps again, borders in the welfare area in that it would increase costs of water treatment. Chlorine demands go up and this sort of thing.

So it is not just a case of an appearance, this is what I am trying to say.

MR. FRANGOS: But again, it all seems to hang on eutrophication? In other words, all the problems that we associate with algal growth and algal blooms. Again, this is the key as you see it. If we get eutrophication then we get color problems, we get treatment problems, we get severe upset. I suppose eutrophication by definition is a severe upset of the ecological system.

DR. MOUNT: Yes, I think in this broad definition that is true.

MR. STEIN: Any other questions or comments?

Go ahead.

MR. FRANGOS: One other one, Mr. Chairman.

You cited a couple of figures on the phosphorus loadings to the lake, comparing at least the potential in the taconite discharges with the municipal discharges. Do we have somewhere tabulated at least the estimate of the total phosphorus discharges to the lake? I am trying to get this in a total frame of reference.

MR. STEIN: Why don't you answer that?

MR. BRYSON: Yes, we have the estimated tabulation from the various States in the Basin in pencil form here. We can make copies available.

MR. FRANGOS: All right, fine. I would like to see that. You may have presented it at sometime before, but it would be helpful.

MR. BRYSON: Yes, it was presented at the last conference.

MR. FRANGOS: All right, fine. If you could pull that for me, I would appreciate it.

MR. STEIN: Does this include Canadian sources?

MR. BRYSON: No, this is from the U. S. portion.

MR. STEIN: Right.

MR. BRYSON: And it does not include contributions from runoff , for example. This just includes municipal and industrial point sources in the Lake Superior Basin, U. S. portion.

DR. MOUNT: Then it doesn't even include the tributary input, really.

MR. BRYSON: No, point sources.

DR. MOUNT: I think this is a key point here, that we have not measured all of these sources, and there are quite a number of them when you look at the total package.

MR. STEIN: But in our phosphorus control program--and this goes with all the amounts--we recognized the limitations. All we were doing was dealing with reductions from municipal and industrial point sources. And the point is you have them all here, and of course Reserve, as any other, is an industrial source. And when you consider the question is what form, of course, the phosphorus is in-- we get that with manganese; we get that with zinc; arsenic, lead, whatever you are putting out-- you have to find out what form it is coming out in and what its availability is.

So I just use these gross and total figures to give you an idea of the sources coming from various places.

I don't know that we have any phosphate loadings anywhere from ground runoff. I don't want all you people to think that it is peculiar to Lake Superior or any of the lakes on that — this is one of the deficiencies in this work. As you people know who have been--I know Mr. Purdy knows this--where we have moved along a little farther with the phosphate removal program in other of the lakes, we are trying assiduously to get those agricultural figures and land runoff figures and we are making very, very slow progress indeed on that. We crept through on the Maumee Basin, but we haven't had many successes other than that up to now. These figures are very hard to get.

DR. MOUNT: Mr. Chairman--

MR. FRANGOS: I am not questioning the philosophy for requiring another removal on those identifiable sources. You know we have been proceeding in the other lakes. But I requested the information just to get a better feeling for it.

DR. MOUNT: I think, Mr. Chairman, you might have left an impression which I know you don't mean to leave and that is, you mentioned about the availability of any of these materials. This is certainly one question, but potential availability or future availability is certainly equally important in looking at the effects of these. For example--

MR. STEIN: Right.

DR. MOUNT: --we have made some measurements of pH in sediments in Lake Superior and we know the pH's are well below 7 in some cases, so that the availability up in the lake water may be one thing and the availability in these sediments may be quite another thing, so they are both important.

MR. STEIN: That's right. I am very happy to emphasize that point, Dr. Mount.

Again going back to our recent mercury experience. Everyone knew mercury was around in some places, but they thought it was tied up in inorganic form and was not available. Then what did we find? At least the prevailing view now is that a good portion of this mercury lying around in our waters in inorganic form gets transformed, a lot of people think by the action of bacteria, but gets transformed into methyl mercury, and once that happens it gets taken in by the fish and gets taken in by the biota that the fish eat and gets into the human food chain. And no one thought that occurred.

I think again when you talk in terms of endangering, you really don't take a chance in the environment, it seems to me, and put out large quantities of potentially deleterious elements in the environment with the notion that they are combined in a form where they are relatively inert without having some pretty good knowledge that over a period of time the action of the environment itself that they are placed in won't change their form and they won't become available for ingestion by biota or by humans. And I think that is a very vital point.

Are there any other comments or questions?

If not, thank you very much, Dr. Mount.

I think what we are going to do, Mr. Badalich has some other stuff to put in the record, and after we get through with that we will recess until tomorrow, when we will give Reserve an opportunity to present its views.

Mr. Badalich.

MR. BADALICH: Mr. Chairman, I believe I may have one more representative here to give a verbal statement and that is from the Village of Aurora. Is

Mayor Glavan here or Herman Zuponcic?

They indicated that they would be here and they would be the last statement, other than written statements I would like to enter into the record.

MR. STEIN: Do you see him here?

MR. BADALICH: I don't.

MR. STEIN: Why don't you proceed with the written statements and if they come in before we recess tonight or come in tomorrow, we will be able to put them on.

MR. BADALICH: Mr. Chairman, Mr. Tuveson will pass out the written statements.

The first one I have is from the Village of Wrenshall. This was prepared by Michael J. Haas, their attorney. I would like to have this statement entered in the record.

MR. STEIN: All these statements, unless you indicate to the contrary, will be entered into the record as if read.

MR. BADALICH: O.K. The next one is the Village of Iron Junction, transmitted by Frank Klabechek, the Mayor.

The next statement is from the Village of

Babbitt and this is submitted by the Mayor, Richard Mahal, and also by the Public Utilities Commission.

The next statement is a statement of Mr. J. W. Dallman, Manager for the Wrenshall Refinery of Continental Oil Company, Wrenshall, Minnesota.

And the last statement is from RJR Foods, and this is submitted by Mr. Jim Bingham, the Executive Plant Manager.

(Which said statements follow:)

YETKA & NEWBY
ATTORNEYS AT LAW
RELIABLE BUILDING
CLOQUET, MINNESOTA 55720
TELEPHONE: 879-3338

LAWRENCE YETKA
H. L. NEWBY, JR.
MICHAEL J. HAAS

WHEN REPLYING, MAKE
REFERENCE TO FILE NO. ________

August 7, 1970

Lake Superior Conference on Water Pollution
Duluth, Minnesota

Re: Village of
Wrenshall

Gentlemen:

The Village of Wrenshall's disposal system was installed in approximately 1964. It services approximately 30 homes in the Village of Wrenshall and the system is a lagoon type system with two lagoons. The State of Minnesota has requested that a phosphate reduction facility be installed for the affluent run off, which the agency apparently maintains is entering the Lake Superior basin. The lagoon in question covers approximately 3½ acres, with a depth of approximately 7 feet. There are gates between the two lagoons and there is a gate to control the affluent run off from the second lagoon.

In the years in which this disposal system has been used, there has been no affluent run off and the total sewage is contained within the two ponds. This'is probably due to the fact that the number of people being serviced is very small. It follows therefore, that with no affluent run off the nutrients which would be damaging to the Lake Superior tributaries are being held within the 3½ acre lagoon area.

Because of the unique position of this small Village of Wrenshall, the Village Council feels that a variance from the ordinary standards is justified in the fact that there is no affluent run off, and that the construction and maintenance of a facility for phosphate removal for an affluent which does not exist is not reasonable.

We ask your consideration of this proposal and we will be very happy to supply any further information which you might request.

Sincerely yours,

VILLAGE OF WRENSHALL

by________________________
Michael J. Haas, Its Attorney
YETKA & NEWBY

To: State of Minnesota
Pollution Control Agency

From: Village of Iron Junction
St Louis County

Subject: Sewage disposal

In 1963 the Village of Iron Junction with the aid of a Federal APW Grant and a gift from the DM&IR Ry. Co. was able to build a septic tank which was designed by Earl Ruble Associates of Duluth and was approved by the Minnesota Department of Health to serve the village. This system was designed to serve 150 people. Presently there are 16 families with a total of 51 persons using this facility. This approximates 1/3 of the village population of 167. Thus 2/3 of the village residents operate their own individual septic tanks. Financially we are unable to support any construction other than emergency repairs to the present system. Families using the system contribute to its maintenance with monthly fees. Receipts for operating the water and sewer system in the village amount to approximately $1000 annualy. Maintenance ofthe system last year totaled $984.41. The total general fund for the village amounts to approximately $3500 annualy and this is all required for general village expense.

Our present sewage and water systems originally belonged to the DM&IR Ry. Co. and were turned over to the village with enough monies to build the present septic tank.Any further expansion of the system would be a financial burden to the 16 families who now use the system. Furthermore the village has no full time employees and even maintenance of the present system is done largely on a voluntary basis.

The effluent from the village septic tank empties into Elbow Creek and thus into the St Louis River.Sewage from the City of Eveleth also passes this same route by way of Elbow Lake. Any investigation of the waters of Elbow Creek must be made with this in mind.

We as much as anyone want to save Lake Superior but due to our present financial status we could not even afford a 50% grant from federal funds or after completion of a new facility afford to employ someone to operate the system. We are open to any suggestions you may have to solve this problem

Frank Klabechek - Mayor

Herbert Moline - Clerk
2-5-70

STATE OF MINNESOTA,
POLLUTION CONTROL AGENCY,
Mr. John Badalich, Director:

CONFERENCE OF THE FEDERAL POLLUTION CONTROL AGENCY.

Dear Sir:

In regard to the recommendations of the FEDERAL-STATE CONFERENCE on POLLUTION of the Waters of Lake Superior and tributary basin, we wish to make the following statement:

The VILLAGE OF BABBITT is working with Nalco Chemical Co. To develop a Coagulation process for the reduction of Phosphates from our waste water plant effluent. Preliminary sampling has been done and samples are being analized by the NALCO LABRATORY PEOPLE. When the lab results are completed and cost estimates can be made, a final decision will be made on the use of this process.

HOWEVER,

The map attached shows some information we hage gathered in our sampling endeavors. This map is a cut out section from a United States Dept. of Interior, Geological Survey, Map. It shows the West end of the Babbitt townsite, The Babbitt Sewage Plant, a Pond called Hay Lake, Mud Lake and the Source of the Embarrass River.

The Babbitt Waste Water effluent enters Hay Lake at the point marked in Red. Sampling Points and results are also marked in Red on the Map.

The Embarrass River along with the Partridge River form part of the head waters of the St. Louis River.

We would like now to quote from a paper on the subject of cummingtonite given by Professor John Green, Professor of Geology, University of Minnesota, Page 1685, Volume 4, May 13,, 14, 15, 1969. Pollution of Lake Superior and its tributary Basin Conference, Paragraph 3 "quote": "The River meanders for most of the 115 miles from the source of the Partridge (we add THE EMBARRASS) at Babbitt sluggishly through the '100 mile Swamp" on its way toward the steeper drop from Cloquet to Fond du lac. Thus no cummingtonite could have been eroded from the Biwabik Iron formation, even by this one of the many tributaries to the St. Louis River and if it had been, it would have had ample opportunity to settle out or be drastically diluted with normal glacial-clay particles during its passage toward the Lake."

We would like again to refer to the attached map. You will note that the effluent from the Babbitt Sewage Plant has a phosphate reading of 8.5 MG/L. This effluent flows in a ditch and enters Hay Lake as indicated. Sample point #2 at the West end of Hay Lake indicates a phosphate reading of.73. Note that there is no physical connection between Hay Lake and Mud Lake. Phosphate readings at the South End of Mud Lake were .62 MG/L. Again note that there is no physical connection from Mud Lake to the source of the Embarrass River.

Sample points 4, 5, and 6, are at intervals along the Embarrass River and Read from East to West, as follows: .12, .08, .05 M. G./L. Sample point #6 being about 6 miles west of #5 and not on this map.

In view of the above information, we ask, that this conference consider issuing a variance to the VILLAGE OF BABBITT on phosphate removal.

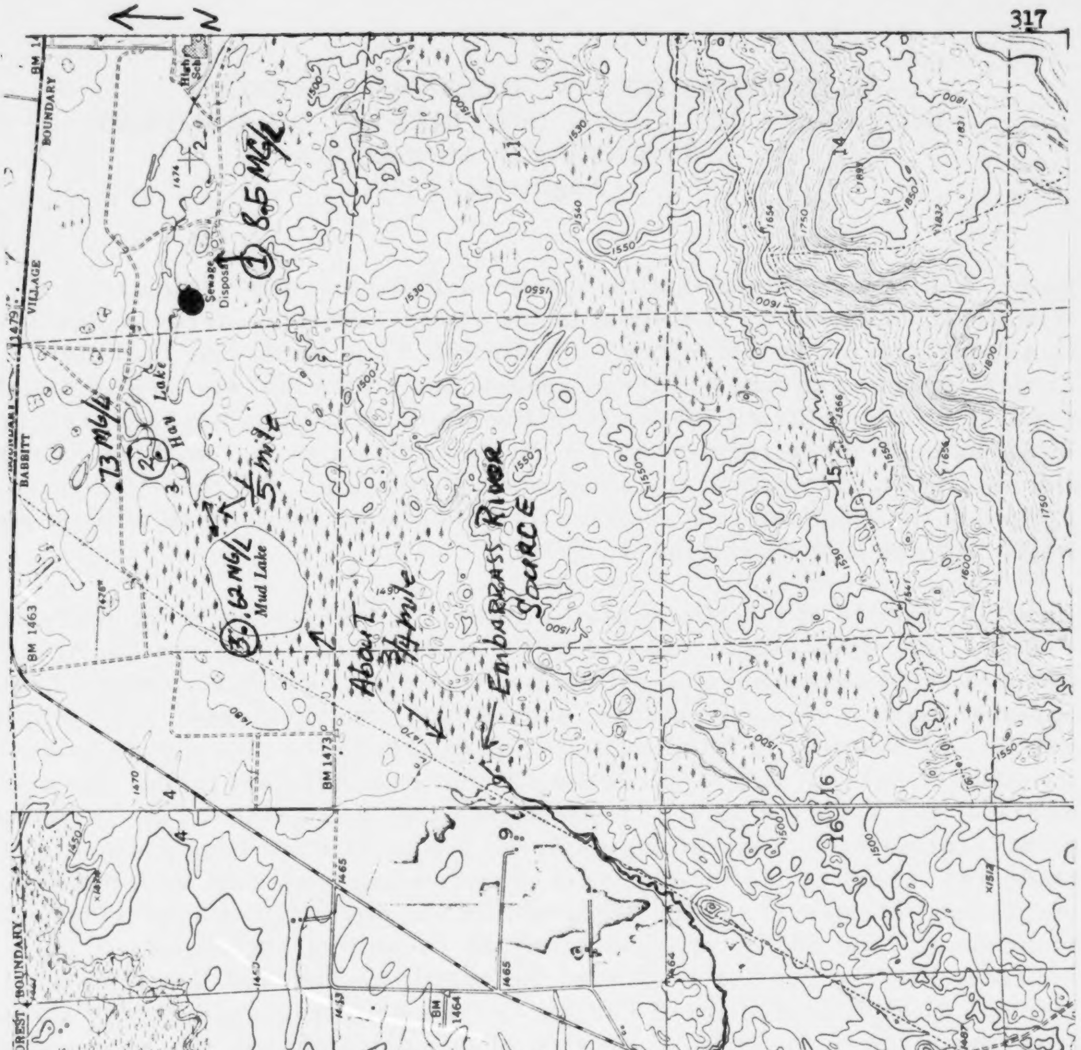
PUBLIC UTILITIES COMMISSION:
VILLAGE OF BABBITT, Babbitt, Minn.

Don Cole
Don Cole, Chairman

C F Corley
Chris Corley, Commissioner

Eldo F Jordan
Eldo F. Jordan, Commissioner.

Richard Mahal
Mayor, Richard Mahal,
VILLAGE OF BABBITT, Babbitt, Minn. 55706.


N
BABBITT VILLAGE BOUNDARY
FOREST BOUNDARY
High Sch
Sewage Dispos
① 8.5 MG/L
② .73 MG/L
Hay Lake
1/5 mile
③ .62 MG/L
Mud Lake
About 3/4 mile
Embarrass River Source
④ .12 MG/L
⑤ .08 MG/L
Embarrass
BM 1463
BM 1473
BM 1464
BM 1447
BM 1470
11
13
14
15
16
4
5
6
7
8
9
18
1450
1500
1550
1600
1650
1750
1800
1850

STATEMENT OF J. W. DALLMAN, MANAGER
WRENSHALL REFINERY, CONTINENTAL OIL COMPANY
WRENSHALL, MINNESOTA
August 12, 1970

Item 1 - It is understood that the Continental Oil Company refinery at Wrenshall, Minnesota, is subject to the Federal State Conference Regulations promulgated by Secretary W. J. Hickel. The Minnesota Pollution Control Agency summary of these regulations states that continuous disinfection must be provided for all industrial effluents containing pathogenic organisms. In response to these regulations we have completed design work on chlorination facilities. Materials and equipment are on order and these facilities, providing the required treatment, will be in operation on these effluent waters which require it by November 1, 1970.

Item 2 - Item 10 of the Minnesota Pollution Control Agency's summary of the Federal State Regulations adopted by Secretary Hickel requires the Agency to indicate sources discharging pollutants, including nutrients, into the Lake Superior Basin. The Agency has indicated that the Continental Oil Company refinery at Wrenshall, Minnesota, needs to reduce the phosphorus content of its effluent water if it is to meet the effluent standards set forth. We are aware of the Agency's desire to effect area treatment rather than individual plant treatment. We therefore employed a firm of consulting engineers to study and report on the feasibility of participating cost-wise with the Village of Carlton, Minnesota, in the construction and operation of a tertiary treatment plant. The report received from the consulting engineering firm indicates that the greater portion of the cost to us involved in a joint treatment plant with the Village of Carlton is the construction of a forced sewer from the refinery to Carlton. In view of this development, we are presently evaluating the cost of constructing inplant equipment for tertiary treatment of our effluent water. As soon as this information becomes available, we will be able to determine the best method of complying with the regulations set forth. Because of the two courses of action which can be taken to solve this problem and because we are not yet in a position to select the best course of action, we cannot enter into a stipulation with the Minnesota Pollution Control Agency at this time. If it develops that the most practical and economical means of solving this problem is to build our own facility, we can see no reason at this time why it could not be in operation by January 1, 1975. If we transfer our effluent water to a combined plant with a municipality, the effective date of operation would be determined by the municipality involved.

J W Dallman

J. W. Dallman

RJR Foods, Inc.
5020 Roosevelt Street
Duluth, Minn. 55801
Telephone 218 628-1021

RJR Foods

August 12, 1970

Mr. John Badalich
Executive Director
State of Minnesota
Pollution Control Agency
717 Delaware Street S.E.
Minneapolis, Minnesota

Dear Mr. Badalich:

Attached are two reports on plant effluent concerning RJR Foods, Inc., West Duluth Plant facilities.

1. A report from our Plant Engineer describing the discharge water, swamp area, and also finding a problem and making the necessary corrections.
2. A report from Ruble and Kaple, Inc., Consulting Engineers of Duluth, Minnesota showing the analysis of our waste water taken at our final discharge pipe flowing into the swamp area which concludes that the water we are discharging into the swamp area is clean water.

We have set up a twice daily visual inspection of our discharge facilities so we may be immediately aware should any change in the water discharge take place. This is a very remote possibility because of the corrective action we have taken.

Very truly yours,

RJR FOODS, INC.

Jim Bingham

Jim Bingham
Executive Plant Manager

JB:el
Enc.

FOODS

R.J. REYNOLDS FOODS, INC.

INTER-OFFICE CORRESPONDENCE

DATE: August 11, 1970

TO: Jim Bingham

FROM: Art Christensen

SUBJECT: Water Problems

I hereby certify that this plan, specification, or report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Minnesota.

Date 8/11/70 Reg. No. 6381

CHRISTENSEN
REGISTERED PROFESSIONAL ENGINEER

Our plant effluent is separated into two discharges. One discharge is piped to the city sanitary sewer, and the second discharge is piped to a swamp immediately north and west of our property. Point of discharge into this swamp is 1,200 ft. from St. Louis Bay.

The first discharge piped, to the sanitary sewer, collects all floor drains, wash stations, sinks, lavatories and toilet facilities. The second discharge, discharging to the swamp, collects only retort cooling water and condensate from heat exchangers.

Results of tests conducted last October on discharged retort cooling water showed a BOD of 25 mg/L, which is within limits established by the State of Minnesota Pollution Authority.

Results of tests conducted in May of this year disclosed a BOD of discharged retort cooling water of 30 mg/L, which is 5 mg/L above the upper limit established by the State of Minnesota Pollution Control Authority.

We investigated to determine the cause of the increase. We found two breaks in our sanitary sewer line in the piping tunnel under our cannery floor. These breaks were leaking solids to the piping tunnel floor and into the retort cooling water trench. We resolved to repair those leaks at our earliest opportunity.

During our plant shut down for overhaul in July, we made repairs to the sanitary sewer lines to stop all leakage.

Results of test, copy attached, show a BOD of less than 1 mg/L which is less than can be measured by standard BOD test.

Art Christensen

RUBLE AND KAPLE, INC. PROFESSIONAL CONSULTANTS
217 S. LAKE AVENUE ○ DULUTH, MINNESOTA 55802
MINN. 218/722-3953
WISC. 715/392-2912

August 11, 1970

Mr. Art Christianson
R. J. Reynolds Foods
200 North 50th Avenue West
Duluth, Minnesota 55807

Dear Mr. Christianson:

The results of the tests run on the water sample collected by our laboratory personnel on Monday, August 3rd, are as follows:

Plant effluent:	B.O.D. (5 days @ 20° C.)	< 1 mg/1
	Coliform organisms	0 per 100 cc.
	Total Suspended Solids	1 mg/1
	Turbidity	1 J.T.U.
	Phosphate as P	.04
	Kjeldahl Nitrogen	< .1 mg/1
	pH	7.2
	Temperature	75° F.

Very truly yours,

RUBLE AND KAPLE, INC.

Gary Baker
Laboratory Division

GB:epm

ARCHITECTURE ○ CHEMISTRY ENGINEERING ○ GEOPHYSICS

MR. BADALICH: And I believe this concludes the statements from the State of Minnesota, other than Reserve Mining Company, which will be, I understand, given tomorrow.

MR. STEIN: Right.

Do any of the conferees wish to say anything?

Are there any people in the audience who feel compelled to say anything if it is very short?

If not--we have this room tomorrow, don't we, Glenn?

We will stand recessed until 9:30 tomorrow, right in this room.

(Whereupon, at 4:45 o'clock a recess was taken until 9:30 o'clock August 13, 1970.)

MORNING SESSION

THURSDAY, AUGUST 13, 1970

9:30 o'clock

MR. STEIN: Let's reconvene.

We will call on Minnesota again. Mr. Badalich.

MR. BADALICH: Mr. Chairman, I have another written statement I would like to present to the conference.

This is in behalf of citizens in the Lake Superior area of Beaver Bay, a number of letters that could be entered into the record.

(Which letters follow:)

Beaver Bay, Minn.
August 3, 1970

To Whom it May Concern:

My parents settled in Beaver Bay in 1907, the year I was born. The family was primarily engaged in commercial fishing, the wholesale fish business, and the operation of a resort. In conducting the wholesale aspect of our business, we operated a boat, the "Dagmar" between Duluth or Two Harbors and on up the North Shore as far as Grand Marais. Years when we were not in the business of buying and selling fish, we fished commercially. Having lived on Lake Superior most of my life and having spent so much time on the water, I feel well qualified to make a judgment regarding visible changes that have taken place. Through the years the water was as clear as a spring, and one could see bottom in 25 to 30 feet of water and viewed from a distance it was deep blue in color. The only time there was a noticeable discoloration was during the spring run off which lasted about 2 weeks. Also during a heavy storm there would be some turbidity near shore but this would clear up as soon as the storm was over. The so called "green water" first appeared soon after Reserve Mining Co. started operating its Plant in late 1955. It was in evidence quite regularly and in 1962 when the Plant expanded the green water appeared more frequently, was more pronounced, and extended farther.

I would say that "Green Water" is now in evidence at least 75% of the time. When the Lake is frozen over one cannot tell if there is any discoloration, but the "Green Water" could be seen almost continously since break-up of this year until about the third week in June. On weekly and semi-weekly trips to Duluth this Spring "Green Water" was clearly visible as far as Knife River, and to a lesser degree as far as Duluth. From the latter part of June until the middle of July, the water was clear but then the discoloration returned and has been in view up to the present.

Reserve Mining Co. spokesmen have said that "Green Water" is a natural phenomenon that was here before the Plant started operating. There is not an iota of truth to this. It has always been the policy of this Company to distort the truth, to confuse and mislead the public and even its own employees.

One reason I chose to live here is because I had not seen a body of water that could compare with Lake Superior. The clear cold water, the clean beaches, the rugged scenic shore-line was something special. A tourist friend of mine once said "you know, I never get tired of looking at that Lake. It's the most beautiful body of water I've ever seen and besides it has mood and grandeur." He passed on some years ago and was spared the heart-break and disappointment of seeing the change that has taken place.

Subscribed and Sworn
Before me on this
12th day of ~~July~~ Aug, 1970
in ~~Lake~~ County, Minn.
ST. LOUIS

Alice R. Jacobson

ALICE R. JACOBSON
Notary Public St. Louis County, Minn
My Commission Expires Aug. 2, 1974

Milton M. Mattson
Milton M. Mattson

Witnesses Mrs. Merna J. Mattson
Mabel B. Macdonald

Beaver Bay, Minn.
July 10, 1970

My name is John de Laittre. I was born in Minneapolis, Minnesota on September 7, 1907, and resided there or in Hennepin County, or at Beaver Bay, Minnesota, until December 31, 1967. Since that time I have been a resident of Washington, D.C.

During every summer for the past fifty years I have visited or sojourned for at least short periods, and more often long periods of time at Beaver Bay, Minnesota, on the premises of the Beaver Bay Club located directly above and on the shore of Lake Superior. My visits during the past forty-eight years have been at the log cabin built and owned by my Father and Mother, and more recently owned and maintained by my wife and myself.

The many days of our visits or sojourns at that cabin, which has an excellent view of Lake Superior from nearly fifty feet above the Lake level, have given me vivid knowledge of the color and clarity of the waters of Lake Superior.

From these observations over the past fifty years, it is my opinion:

(1) That until 1955 the waters of Lake Superior were clear and of a beautiful blue color except that in shallow waters or on reefs a clear bright green color prevailed. This, of course, was not actual discoloration, but rather the reflection of light from the bottom.
(2) That since 1955 these waters have been subject to clouding and discoloration, so material that the appearance has been predominantly greenish and powdery in color on almost all occasions of my observation.
(3) That the intensity of such clouding and discoloration has varied with the currents of the Lake and the prevailing winds.
(4) That such clouding and discoloration has been caused by the direct discharge into Lake Superior of tailings from the beneficiation of taconite by the Reserve Mining Company at its plant at Silver Bay, Minnesota.

John de Laittre
John de Laittre

Subscribed and Sworn
before me on this
10th day of July 1970
in Lake County, Minn.
Milton M. Mattson

Witnesses
Roy W. Hangartner
Carolyn E. de Laittre

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977.

Reproduced from best available copy.

East Star Route
Box 1 Silver Bay Minn.
July 25, 1970

To Whom it May Concern:

I came to the North Shore of Lake Superior in 1923 and settled near Williams Creek located about 1½ miles East of Silver Bay. Except for about 4 or 5 years I have been a full time fisherman up to the present. Having spent this long span of time on the Lake, I feel better qualified than most people to make an appraisal of any change that has taken place. Over the years the Lake was crystal clear and one could see bottom down to 30 feet. Not once did I see the so called Green Water. However, when Reserve Mining Co., started dumping tailings into the Lake, a great change took place. Green Water started to appear from time to time and seems to occur more frequently as time goes on. There are times when bottom cannot be seen in 1 foot of water. After the ice left this Spring Green Water was present almost every day until June. The Company has said there was Green Water here before the Plant started operating. This is clearly a distortion of the truth. I reiterate, again, there was no so-called natural Green water before 1955. However, when Reserve Mining Co.,built its break waters, this did cause some Green Water to be present in the area.In the course of blasting, some fines were mixed in with the large rocks, and this would explain the prescence of green water in the construction of the break waters. It is possible that colored pictures could have been taken of this discolored water and this, of course, could be represented as the presence of Green Water before the plant started operations.

In the early years, the herring fishing was good and it was not uncommon to come ashore with the skiff loaded. In the fall, and winter we made these catches right up close to shore. In recent years the habits of the herring seem to have changed. No longer do we get the heavy fall spawning run in shallow water. I have had to go out in the Lake several miles to catch any fish at all and the catches are small. Also the herring disappear when there is Green Water around the nets. Usually the water has to clear for a few days before the fish return.

I am saddened that the beauty of the Lake has been partially destroyed, not to mention that I have suffered financially.

Roald R. Midbrod
Roald Midbrod

Subscribed and sworn
before me on this
27 day of July 1970
in Lake County, Minn.

Milton M. Mattson

MILTON M. MATTSON
My Commission Expires [illegible] 1977

Witnesses

Mrs. Verna J. Mattson
Mrs. Helvia Midbrod

4639 Williston Road
Minnetonka, Minn.
July 18, 1970

I, Mary N. Jensen, have been a summer resident at Islet Bay, Minn. since 1928 when I was eleven years old. It was this year that my Father, Dr. Martin Nordland erected a cabin at this site. In addition to the summer vacations, I have spent many week ends enjoying the beautiful clear waters of Lake Superior. However, when Reserve Mining Company built its plant in Silver Bay in late 1955, there has been a dramatic change in my enjoyment of my vacations at Islet Bay. The water previous to 1955 was clear and blue in color. Since 1956 there have been many occasions when Lake Superior had a hideous murky green coloration which seems to vary in color intensity, with current and light intensity. In my opinion this dramatic change from blue to green is caused by the effluent discharge by Reserve Mining into Lake Superior.

For many years I drank the water from the Lake, however, since 1956 I have discontinued drinking the water because of the apparent impurities in the green water.

In my opinion, Reserve Mining Company should be compelled to dump the taconite tailings on land instead of into Lake Superior.

Mary N. Jensen
Mary N. Jensen

Subscribed and Sworn
before me on this
18 day of July 1970
in Lake County, Minn.

Milton M. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977.

Witnesses:

I. L. Jensen

Mildred H. Nordland

2124 Kenwood Parkway
Minneapolis, Minn.
July 18, 1970

To Whom it May Concern-

I first made a trip along the North Shore of Lake Superior on the Steamer America in 1912. Since that time I have come to the North Shore almost every year. In 1928 my husband, Dr. Martin Nordland, and I built a cabin at Islet Bay, located 6 miles West of Silver Bay. From that time on we spent almost all our vacations at Islet Bay. Also we would spend as many week-ends as we could at the cabin.

I feel that I have spent enough time on Lake Superior so that I am qualified to make a Statement regarding any change in the appearance of the water. In all the years I came to the North Shore, I never observed any Green Water until about 1956. Previous to this the water was crystal dear and bottom could be seen at a considerable depth. Since the "start up" of the Plant, Green water has been apparent most of the time.

I am of the opinion that Reserve Mining Co., should be compelled to put the tailings on land and that dumping in the Lake must be stopped.

Subscribed and Sworn
Before me this 18 day
of July 1970 in
Lake County, Minn.

Mrs Mildred Nordland
Mrs. Mildred Nordland

Milton M Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977

Witnesses

Margaret Z Jacob
H. Jensen

Beaver Bay, Minnesota
July 22, 1970

Since 1933 I have spent part of every summer at Beaver Bay. In recent years I have been shocked and saddened to see the ruthless devastation the Reserve Mining Company has been permitted to bring about in this beautiful part of the state of Minnesota.

They have gouged out one formerly lovely bluff, completely ruining its beauty. They have wrecked a charming little island and, by dumping their tailings into Lake Superior have seriously injured the once prosperous fishing industry and have turned large portions of the once deep, sapphire blue lake into a sickly, muddy, pale green.

A large part of the time a heavy cloud of black smoke can be seen on the horizon and the residue from this smoke is wafted across Beaver Bay settling on the leaves of trees and collecting on verandas.

All this is just another example of the pollution and destructivness which has been and is being practiced all over our country.

For one who has loved and enjoyed this beautiful part of our state it is heart breaking to see what has been allowed to happen here.

I urge that this devastating ruining of our area be stopped before it is too late. The time to do this is NOW.

Martha M. Wilkinson
Martha M. Wilkinson

Subscribed and sworn
before me on this
25 day July, 1970
Lake County, Minn.

Milton M. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977.

Witnesses Mary Jane D. Savage

George C. Hartp

East Star Route
Silver Bay, Minn.
July 5, 1970

I have lived on Lake Superior in the vicinity of Palisade Head since 1914 and I have fished commercially since 1928.

To see most of the western 60 to 80 miles of the Lake discolored at times from taconite tailings, is truly saddening. I never did see Green Water before Reserve Mining Co., started to produce pellets in 1955. Even though I live North East of the plant where Green Water is not as prevalent as to the Southwest, I still see it frequently. In the course of my commercial fishing I have mede the observation that Green Water can be present at the surface and not down deeper. It has happened that nets set at greater depths were clean and showed no evidence of tailings. At other times the water is clean as far down as one can see and nets set deep are loaded with tailings. On May 13, 1970 I drove to Tofte, Minn., before I saw the end of a wide streak of Green water knifing through the other wise Blue water. The Green Water has been constantly visible from Silver Bay to Duluth since the ice left the Western end of the Lake this Spring up until the latter part of June.

A news release in the Duluth News Tribune of May 12, 1970 seemed to gloat over a Minn., P.C.A. report that the water in the area of Reserve's Plant was excellent. The report was based on samples taken during a three day period in Nov. 1969. Over a period of several weeks in Nov., and Dec., I noticed that the water was clear 2 to 3 miles out and that the Green Water extended beyond this.

The sick feeling I get when I see the vastness of the Green Water, is even worse than the sting from loss of income due to the waste. We love this Lake and are saddened by the change that has taken place.

Edwin Hess
Edwin Hess

Subscribed and Sworn
Before me in Lake
County, Minn., This 24 day
of July 1970

Milton M. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1972.

Witnesses:
Herbert W. Clow

Box 117, East Star Route
Two Harbors, Minn. 55616
July 1, 1970

TO WHOM IT MAY CONCERN:

My name is John Lind. With the exception of about ten to twelve years I have lived on the shores of Lake Superior or its environs since 1906. I am now almost seventy years of age.

In 1938 my wife and I began building a cabin resort between Split Rock and Gooseberry Rivers. At all times we have obeyed all health regulations given to us. We have lived here continually since 1938, bringing up two fine children.

During the first years of our resort operation we had no well, so we used Lake Superior water, dipped out of the lake. It was pure and clear, except for short periods during spring freshets and after heavy rains, when it would be muddy or brownish in color, the color coming from clay banks or swamps. At other times the color of the water was a deep blue-and still is pretty much that color Northeast of Silver Bay.

But, since the mid-fifties or shortly thereafter a noticable change began taking place in the color of the lake water, especially in the direction of Duluth and beginning at the dumping delta of the Reserve Mining Company at Silver Bay. From a dark blue it began turning to a green which resembled the color of pea soup, of which we have vivid 8mm color film and 35mm color slides to compare with the earlier pictures taken twenty years or so ago.

The Reserve Mining Company has admitted to a minimal discoloration of the water from its effluent, but to our eyes and to our cameras this discoloration is not minimal, but is of such depth and intensity that at times it changes the color of the water off the shoreline into a pea soup green as compared with the bluish water farther out from shore. In our travels up and down the North Shore we have not found this phenomena anywhere else than between Silver Bay and Duluth.

This cannot, in my humble opinion, be considered anything but pollution, as any foreign material dumped into clean water must in some way change that water. In short: it pollutes it.

As taxpayers and residents of the North Shore we wish to retain our lake in as pure a state as possible, and we petition the courts, state officials and federal authorities to take such action as is necessary to keep our waters, and our whole enviroment, at a healthy level for man and animal, as well as plant life.

John Lind
Mrs J Lind
Mr.&Mrs. John Lind

Subscribed and Sworn
Before me on this
25 day of July, 1970
in Lake County, Minnesota
Milton M. Mattson

Witnesses
Mrs. Merna J. Mattson
Reino Taari

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977

Grand Marais, Minn.
July 25, 1970

POLLUTION IN LAKE SUPERIOR

I have been driving between Two Harbors and Grand Marais every day for the past 16 years and have seen the change in color of Lake Superior water, in a large area, covering many miles East and West of Reserve Mining Company's taconite tailing outlet into Lake Superior.

These tailings may not be harmful or poisonous but it is changing the appearance and beauty of the Lake . Who wants colored water in a Lake that is supposed to be pure and clean.

Reserve Mining and other polluters of Lake Superior should find other ways of disposing of their waste material at once before the problem gets beyond control.

O. J. Ege
O. J. Ege

Subscribed and sworn
before me on this
27 day of July 1970
in Lake County, Minn.

Milton M. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977

Witnesses:

Sharon J. Kofstad

Mrs. Mirna Mattson

3024 30" Ave. So.
Minneapolis, Minn.55406
July 20,1970.

To the Minnesota Pollution Control Agency,

In 1910 I cameto Beaver Bay from Norway. What a beautiful sight Lake Superior was,so much like the land I had left.

In the fall of that year I started commercial fishing, we got as much as fifteen to eighteen hundred pounds of herring a day. The water was crystal clear, and a man could make a good living for himself and his family.

From 1920 to 1927 I was an engineer on Mr. Ed. Mattson's boat that traveled from Duluth to Isle Royale Mich. buying fish from the fisherman along the shore. The water was always pure and clear at that time and one could see the bottom at 20 feet depth or more.

About 1947 I stopped commercial fishing. We moved to Minneapolis, but we spend our summers here at Beaver Bay.Since then I have gone out many times with the fisherman here,and found the water clear, until about 1956 I discovered the water was cloudy and had an unfamiliar appearance. Fish were much harder to get, you could not see the bottom at four or five feet depth as we once could,and from then on it has continued to get worse.It is impossible for a man to make a living at fishing any more. Now they must go out eight to ten miles into the lake to get a comparitive small catch. This is very risky for the men in the fall of the year, because of sudden storms.

Unless something drastic is done soon to preserve Lake Superior, from the taconite tailings of Reserve Mining Company,I fear Lake Superior will have the tragic fate of Lake Erie. It is hard to stand by and see this happen because of the greed for wealth of a few.

Sincerely,

Oscar A Lovold

Subscribed and Sworn
Before me on this
20 day of July 1970
in Lake County, Minn.

Milton M. Mattson

Witnesses

Mrs. Merna J. Mattson
Mabel [illegible] Macdonald

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977.

East Star Route
Silver Bay, Minnesota

To Whom It May Concern:

I was born and raised on the North Shore of Lake Superior in the vicinity of Palisade Head. I started to fish commercially in 1945 and except for 2 years of military service this has been my main occupation most of the time. Since 1959 I have continued fishing, but on a part time basis.

October of 1956 was my first encounter with the green water. The fishing was exceptionally heavy and we came ashore with boat loads of herring. Then the green water closed in and in two days the herring disappeared completely. The water was discolored for over a week before it cleared up and in about two days the fishing improved again. The commercial fishermen started complaining about the green water in the fall of 1956 and in August 1957 Earl Ruble, a consultant to the Minnesota Water Pollution Control Commission came around to check out the complaints. I never heard from him again. The lake is steadily getting worse. I often see green water 8 to 10 miles out in the lake where I have my nets set. I make frequent trips to Knife River or Duluth and I quite often see green water all the way to the end of the lake.

In all my years of fishing I never did see green water until the plant started operating. However, during the spring run off and during a heavy storm the water would get discolored, but the color was brown-not green.

Subscribed and Sworn
Before me on this
29 day of July, 1970
Lake County, Minn.

Milton M. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977

Robert C Midbrod

Robert Midbrod

Witnesses

Beaver Bay, Minnesota
July 16, 1970

To Whom It May Concern:

I was born and raised in Beaver Bay, and over a period of 40 years I have spent considerable time on Lake Superior in the vicinity of this community. I have my own lake property, boat house, and fishing station. Before 1955 I fished intermittently but since that year I have fished on a full time basis from October until freeze up. During the balance of the year I have fished part time. Before 1955 one could catch all the herring one could handle within ½ or ¼ miles of shore when the fall run was on. When the green water came and I fished out from shore 2 or 3 miles to get away from the tailings from the Reserve Mining plant. Even then the green water too often closed in around the nets. The result is no herring the next day and there is no fish until the discolored water disappears. Herring will not live or be found in anything but clear, clean water.

This discharge from the Reserve plant discolors the water with a pale, greenish hue that sometimes can be seen as far Southwest as Two Harbors, and beyond and several miles out, towards the Wisconsin Shore. It can also sometimes be so dense that a white object cannot be seen in more than a foot of water. This is mostly due to the Northeast current which is the prevailing current in the fall, winter and spring, bringing the tailings to the shore and sweeping it in a southwesterly direction.

In my years as a fisherman on this lake and having flown over, and been around it almost constantly, I feel I am in an excellent position to speak on the subject. Before 1955 there never was such a thing as the pale green water we see today and there is no other place it comes from but the Reserve plant at Silver Bay. It is totally irresponsible for anyone to call this a 'natural phenomen'- it is not! It is simply and plainly, taconite tailings--nothing else!

Anyone whom is skeptical of where this 'green water' comes from should take a plane ride along this shore at 5000 feet when Reserve Mining is operating at full capacity and a strong Northeast current is running and it will clear all doubts from his mind.

Sincerely,

Roy W. Hangartner
Roy W. Hangartner

Subscribed and Sworn
Before me in Lake
County, Minn., this
27 day of July, 1970

Witnesses

Mrs. Merna J. Mattson

MILTON M. MATTSON
Notary Public, Lake Co., Minn.
My Commission Expires April 8, 1977

MR. BADALICH: I believe that is all of the written statements I have, Mr. Chairman, and I think at this point I would like to call upon Reserve Mining Company to make their presentation.

MR. STEIN: I have a telegram here from a Richard White, President of the Board of Education, which I would like to put in the record, too, without objection.

(Which telegram reads:)

"MR. MURRAY STEIN
HOTEL RADISSON DULUTH MINN

"RESERVE MINING SHOULD NOT BE GRANTED A PERMIT TO DUMP INTO LAKE SUPERIOR A REDUCTION IS NOT SUFFICIENT IT MUST BE STOPPED I AM A CONCERNED CITIZEN AND PRESIDENT OF A BOARD OF EDUCATION AND WE MUST LOOK OUT FOR THE NEXT GENERATION

"RICHARD WHITE 398 LAKEWOOD LANE
MARQUETTE MICH"

MR. BADALICH: If I may, Mr. Chairman, I would like to call upon Mr. Ed Fride, who will commence the presentation for the Reserve Mining Company, Silver Bay, Minnesota.

EDWARD T. FRIDE, ATTORNEY AT LAW

SULLIVAN, HANFT, HASTINGS, FRIDE & O'BRIEN
DULUTH, MINNESOTA

MR. FRIDE: Thank you, Mr. Badalich.

Mr. Chairman, conferees, ladies and gentlemen.

We have distributed through the Minnesota conferees copies of the principal statements which Reserve will make this morning, and I would like them to be made a part of the record.

MR. STEIN: The whole package?

MR. FRIDE: Yes.

MR. STEIN: Without objection, this will be entered into the record as if read.

(Which statements follow:)

SUPPLEMENTAL STATEMENT OF RESERVE MINING COMPANY TO RECONVENED SESSION OF THE LAKE SUPERIOR CONFERENCE AUGUST 12 AND 13, 1970, IN DULUTH, MINNESOTA

I. Comments on Previous Session of Conference

It appears appropriate to briefly comment on the testimony presented at prior sessions of the Conference.

At the outset it is suggested that certain conclusions contained in reports relied upon by Secretary Udall in the convening of the Conference have either not been substantiated during the Conference proceedings or have been abandoned for lack of supporting data.

Many of the conclusions of the December, 1968, Great Lakes Region Study by the FWPCA entitled, "Special Report on Water Quality of Lake Superior in the Vicinity of Silver Bay, Minnesota," were not adopted in the official FWPCA report entitled, "An Appraisal of Water Pollution in the Lake Superior Basin," dated April, 1969.

For example, that 1968 report concluded that lead and copper levels in the vicinity of Silver Bay exceeded water quality standards and that, "aluminum, lead, copper, zinc, cadmium and nickel were also found to be in concentrations in excess of commonly accepted levels for supporting aquatic life." (Page 5.) The official report stated with respect to the trace metals bound into Reserve's tailings that: "The chemical state of these metals was not assessed and it would be presumptious to say at this time what portions of the elements enter into solution." (Page 28.)

The official appraisal report relied exclusively on the Minnesota Agency's study entitled, "Bottom Fauna of the Minnesota North Shore of Lake Superior as Related to Deposition of Taconite Tailings and Fish Production," for its conclusion that, "The discharge of taconite tailings to Lake Superior from the Reserve Mining Company, E. W. Davis Works, has a deleterious effect on the ecology of a portion of the lake by reducing organisms necessary to support fish life." (Page 46.) When one examines the state report to ascertain whether in fact it supports a charge of "deleterious effect," it is significant that the report itself refers only to a possible decline in pontoporeia, a bottom scud, and that, "it should be emphasized that the foregoing calculations are not exact, but they do indicate that the effect of the tailings on fish production within the area where tailings are deposited is small and that the bulk of the fish food in the area is of free-swimming (pelagic) organisms (such as fish and mysid shrimps) and not of bottom fauna that may be affected by tailings deposition." (Page 9.) In commenting on that study by the Minnesota Department of Conservation, as well as other studies made both before and since the commencement of Reserve's operations, the Assistant Minnesota Commissioner of Conservation stated to the Conferees on May 13, 1969, that, "Our studies of the record and of the lake indicate that present taconite operations are not currently having an appreciable effect on fish production in the lake." (Page 7.)

The official report also notes, "Information available shows that in Lake Superior, overgrowth of algae is not a problem. The low temperature of the water is very likely a limiting factor in the lake's productivity." (Page 23.) **** "At the present time the main body of Lake Superior has not shown any signs of oxygen deficiency. This coincides with the characteristic of an oligotrophic lake in that there is ample oxygen at all water levels within the lake. In this case, the oxygen levels are at or near the saturation point at all depths." (Page 23.) **** "The bacterial quality of the main body of Lake Superior is excellent." (Page 25.)

Reserve appeared during the first session of the Conference and submitted substantial evidence that the company's discharge had no adverse effect on any beneficial use of Lake Superior. Reliance is placed on those statements and the supporting data submitted with them, as well as on the statement made by Reserve to the reconvened session of the Conference on April 29-30, 1970.

At that reconvened session of the Lake Superior Conference held on April 29-30, 1970, Dr. Donald Mount, Director, National Water Quality Laboratory, presented certain technical reports as well as a summary of what he considered to be the important considerations relating to Reserve's discharge as of that time. In so doing it was clear that many of the charges previously made against Reserve by various sources were either abandoned or found wanting in supporting evidence. He noted that green water masses along the Wisconsin shore did not contain tailings (page 2) and thus obviously Reserve's discharge did not cause or contribute to such occurrences. He emphasized that the discharge of tailings did not have any adverse effect on public water supplies (page 2). He commented that, "One can see that the tailings are being deposited primarily in the deep trough off the Minnesota shore and that on this transect no tailings were found in the Wisconsin portions of the lake." (Page 3.) He said that tailings particles of greater than 2 micron size would not be expected to be transported any substantial distance in the lake (page 3), and that direct toxic effects on fish and fish food organisms were not expected to occur at realistic concentrations of the tailings to be found in the lake, except possibly for local areas near the discharge and in the heavy density current (page 4).

Dr. Mount also reported that at a ten per cent tailings effluent there was slight algal growth promotion (page 4). It is suggested that that concentration is not realistic insofar as the lake is concerned.

In commenting on the bacterial studies, he said, "There is no implication from this data that we should expect to see a bacterial problem in Lake Superior if discharges containing bacteria are adequately controlled." (Page 5.) In concluding, he noted, "In my judgment the effect of Reserve's discharge should be assessed in terms of altering the lake's appearance rather than the toxic effects on fish and fish food organisms, or endangering water supplies." (Page 7.)

In the questions posed by the Conferees following his statement, Dr. Mount said, "Mr. Frangos, I would like to point out again I think it is very important that the algal growth studies which we have reported are only a small number of experiments and I don't think we should make world-shaking conclusions on that amount of data." (Transcript pages 373, 374.)

In responding to a Conferee's inquiry with respect to stimulation of bacteria, Dr. Mount had Dr. Glass of his staff answer an inquiry about bacteria stimulation from tailings as contrasted with any stimulation from natural sediments. "Mr. Frangos: Fine, but there may be other materials that similarly stimulate this kind of growth. Dr. Glass: Oh, certainly. You might derive the same thing from the sediments. Dr. Mount: I think it is a very significant point that we are not dealing with an isolated effect. I believe that is very important." (Transcript page 375.)

In assessing laboratory experiments, care must be taken in translating their results to the lake.

It is suggested that with respect to the bacterial investigations reported by the National Water Quality Laboratory that the most likely source of food for the organisms was in the growth medium that was transferred to the tailings solution by the bacterial inoculant. This comment is reinforced by the fact that there was substantial bacterial growth occurring in the control which did not contain tailings. In addition, the amount of growth attained was not at all proportional to the amount of tailings added.

It is submitted that a realistic appraisal of all the evidence indicates that there is no showing of any change in water quality associated with algal or bacterial growth.

The Conference Summary issued by Secretary of the Interior Hickel on January 26, 1970, stated, "There is presumptive evidence in the record to indicate that the discharges from the Reserve Mining Company endanger the health or welfare of persons in states other than that in which such discharges originate and that this pollution is subject to abatement under the provisions of the Federal Water Pollution Control Act." (Page 10.) In utilizing the term "presumptive," the Conferees said at the September 30-October 1, 1969 Executive Session of the Conference: "Mr. Purdy: What I mean by presumptive evidence is that, as I understand it, these will be continuing, there will be continuing analytical work on samples already collected, and that this may at some later point in time--or that this in some later point in time should be reviewed by the Conferees to make a determination whether there is such a pollution occurring or whether there is not such a pollution occurring." (Transcript page 161.)

It is submitted that a realistic appraisal of the record does not support a claim that Reserve's discharge "endangers the health or welfare of persons in states other than that in which such discharges originate."

II. Lake County District Court Proceedings

While not directly related to the Conferees' considerations, it is believed advisable to bring to the attention of the Conferees the fact that a trial has been held relating to interstate water quality standards and possible pollution by Reserve Mining Company of Lake Superior. Appropriateness of some comment in this area is reinforced by the fact that in the January, 1970, revision of the official FWPCA report entitled, "An Appraisal of Water Pollution in the Lake Superior Basin," the Conference chairman stated, "The purpose of these procedures is to bring together representatives of the states and the U. S. Department of the Interior to review the existing situation and the progress which has been made, to lay a basis for future action by all parties concerned, and to give the states, localities, and industries an opportunity to take any remedial action which may be indicated under state and local law." (Page 48.) Similarly, in the April "Appraisal," the recommendations included that, "The state of Minnesota is urged to take such regulatory actions as necessary to control intrastate pollution resulting from these discharges, if any." (Page 48.) The court action was precipitated by the Secretary of Interior's approval on November 26, 1969, of the interstate water quality standard known as WPC-15. When such approval was issued, that standard became the Federal-Minnesota interstate water quality standard. Certain portions of it would limit Reserve's discharge and preclude the continuance of the present operation contrary to the premise upon which the plant was constructed and has been operating under permits issued by the State and Federal agencies. Reserve was forced to take an appeal within 30 days of the Secretary's action if it desired to contest the reasonableness and validity of portions of the regulation as applied to Reserve. Minnesota Statute 115.05 (10) provides that, "**** if no appeal be taken from **** a regulation **** as herein provided, the action of the Agency shall be deemed conclusive and the validity and reasonableness thereof shall not be questioned in any other action or proceeding." After the appeal from the reasonableness and validity of portions of the regulation was perfected, the Minnesota Pollution Control Agency counter-claimed alleging violation of the regulation, as well as violation of Minnesota law relating to pollution. Trial of that matter occupied from June 22, 1970, through August 5, 1970. Witnesses called by the parties included representatives of the U. S. Department of the Interior, Federal Water Quality Administration, Minnesota Conservation Department, Minnesota Department of Health, Reserve Mining Company, and others. Nearly 300 exhibits were received by the court including information relating to possible alternative methods of tailings disposal and modifications in the present system. Final briefs in that matter are to be submitted by the parties by September 15, 1970.

Considering the extensive evidence submitted to the court and the similarity of some of the issues, we believe the Conferees may wish to give some consideration to the trial court's evaluation of the subject as soon as he reaches a decision.

Respectfully submitted,

Edward T Fride

Edward T. Fride
Attorney for Reserve Mining Company
1200 Alworth Building
Duluth, Minnesota

STATEMENT OF RESERVE MINING COMPANY TO RECONVENED SESSION OF THE LAKE SUPERIOR CONFERENCE AUGUST 12 and 13, 1970, IN DULUTH, MINNESOTA

On January 26, 1970, Interior Secretary Walter J. Hickel issued his Summary of the Conference held in May and reconvened in September, 1969. Included were his recommendations...quote...

> "Reserve Mining Company be requested to undertake further engineering and economic studies relating to possible ways and means of reducing to the maximum practicable extent the discharge of tailings to Lake Superior and submit a report on progress to the Minnesota Pollution Control Agency and the Conferees within six months of the date of issuance of the Summary of Conference by the Secretary of the Interior." End of quote.

Consistent with Reserve's Policy Statement issued September 2, 1969, and widely published prior to the Secretary's Summary and without waiving any question as to the jurisdiction of this Conference, Reserve reported on progress of preliminary engineering studies considering possible modifications of the present method of disposing of taconite tailings. This report was made to the Minnesota Pollution Control Agency April 13, 1970, and to the Conferees April 30. Some 19 tentative plans were reviewed and the current status of those preliminary engineering studies was reported.

On July 29, 1970, in response to a request from Mr. John P. Badalich, Executive Director, Minnesota Pollution Control Agency, Mr. E. M.

Furness, President, Reserve Mining Company, transmitted a letter summarizing Reserve's current situation and stated that, "We are in the process now of testing and translating laboratory data and drafting board information into demonstrable, reliable information."

Following Reserve's progress report to the Conferees on the preliminary engineering studies, every effort was made to hurry to completion the several studies which were unfinished at that time.

As each was completed, Reserve began the second phase of the work --"to prove and evaluate," under simulated operating conditions in Reserve's pilot plant, segments of some of the proposals.

Since last December Reserve's pilot plant, which represents the major portion of the $5 million Research and Development Division complex at Silver Bay, has been used exclusively to develop basic engineering data and evaluate portions of some of the preliminary engineering studies.

Gathering the basic data was of utmost importance since preliminary engineering designs could not be completed without that information. The evaluation activities recently demonstrated their worth when segments of several preliminary engineering studies which appeared sound in the laboratory and on a drafting board failed in the pilot plant evaluation. They simply will not work and cannot be made to work because of the characteristics of Reserve's taconite or some other inflexible consideration.

The pilot plant proved this and is currently providing answers to many vital questions in this evaluation phase, such as:

> Will a particular flowsheet handle taconite from all sections of Reserve's mine? (The crude rock varies

considerably throughout the mineral body in terms of grindability, concentratability, magnetic characteristics, and iron content.)

Can a control circuit be designed to adjust the operations to accommodate these variations?

Which type and make of magnetic separators will perform at the efficiency and capacity indicated by preliminary engineering studies and lab experiments?

Does the present plant have sufficient grinding capacity in existing primary ball mills to permit the use of a fine screen circuit as indicated by the preliminary engineering?

Which flocculents and amines will perform best from an operating, cost, and environmental standpoint? (Of six flocculents which appear workable, only three have been evaluated in the pilot plant. The use of a flocculent or settling agent is required by all of the engineering studies employing thickeners or clarifiers and represents a major operating cost.)

Will recycled water (containing some tailings instead of being clear, raw lake water) cause a "build-up" in continued operations and adversely affect the functioning of the process? If so, how can that problem be solved so that this segment of a number of the proposals will actually be workable?

> What is the actual feasibility of discharging tailings at a point 150 feet below the surface of the lake to create an underwater sand reef? (Pipe is installed to lakeshore only.)

As can be seen from some of the examples cited above, not only is it necessary to evaluate segments of some of the proposals contained in the preliminary engineering studies to make certain they are workable--sound from an operating standpoint--but also to determine rates of flow of material, size and types of pumps, electric motors, magnetic separators, automatic controls, grinding capacities, handling characteristics, material logistics, chemical properties of coagulants, and other matters.

Until these evaluations are complete, it is not possible for Reserve to make any kind of a meaningful decision related to any modification or alteration of its method of tailings handling and disposal.

Every indication is that the evaluation activities will be completed by November 1, 1970.

Attached hereto are details of the above general explanatory remarks:

A. Letter dated July 29, 1970, from Furness to Badalich in response to Badalich letter of July 17, 1970.

B. Document dated August 10, 1970, entitled "Reserve Mining Company Tailings Inventory." This paper and its attached maps show the location and the thickness of the layer of tailings on the bottom of Lake Superior. The data represented in this survey require a full year's effort--taking bottom cores, analyzing each core's surface layer via x-ray, x-ray diffraction, chemistry; an acoustic sub-bottom profiling system; an extremely accurate depth sounder and standard surveying techniques. As a result, virtually all of the 205 million tons of tailings Reserve has produced in its 15 years of operations are accounted for--on the bottom of Lake Superior. More than 90% are located within the nine-square mile "zone of discharge" at Silver Bay, and the complete tailings inventory accounted for 98.5% of the tailings discharged.

C. Memo dated August 10, 1970, Haley to Furness, "Engineering Task Force Activities." This is a chronological listing of the principal activities of the Engineering Task Force. It summarizes the meetings, planning sessions, reports and decisions made.

D. Memo dated August 6, 1970, Haley to Furness, "Tailings--R & D Pilot Plant." This is a chronological summary of pilot plant activities evaluating portions of various proposals--including summaries of meetings, purchase orders for equipment, work orders for fabricating and installing machines, test equipment, etc., execution of engineering drawings, operating results, and other activities.

E. Memo dated August 9, 1970, Haley to Furness, "Project Scheduling Through October, 1970." This summarizes all of the evaluation projects scheduled by Reserve's pilot plant. Virtually any change in the method of tailings disposal brings with it the necessity of changing Reserve's basic processing system--the "flowsheet" Reserve pioneered and has employed for the past 15 years. The schedule shows the dates on which each of the investigations will be performed, inasmuch as a number of the evaluations cannot be scheduled concurrently due to the large number of samples and lab analyses required.

F. "Engineering Task Force Progress Report," revised August 10, 1970. This is an up-dated version of the report on progress made on the preliminary engineering studies which as presented originally to the Conferees April 30, 1970. At that time, a number of the preliminary engineering studies had not yet been completed. For the general infor-

> mation of the Conferees, this report has been brought up to date and the new and supplemental information is printed on colored pages, with the new or revised sections indicated in the margins. See Proposals #13, #15, #17, #18 and #19.

As the Chairman and Conferees know, litigation involving Reserve and the Minnesota Pollution Control Agency is now under consideration by the Lake County District Court following completion of testimony last week. The court has directed both sides to submit briefs by September 15, 1970. The case involves consideration of the reasonableness and validity of certain portions of the Minnesota water quality standard known as WPC-15. Also, the court is considering a State counterclaim requesting enforcement of the regulation against Reserve and a court determination of whether Reserve may or may not be violating State statutes with its discharge.

Trial of these considerations covered six and one-half weeks. Representatives of the Interior Department, the Federal Water Quality Administration, the Minnesota Pollution Control Agency, Minnesota Conservation Department, Minnesota Department of Health, Reserve Mining Company, and others testified and introduced evidence. Nearly 300 exhibits were received by the court, including information relating to possible alternative methods of tailings disposal and modifications in the present system.

We believe the outcome of this court case is of vital concern not only to the Minnesota Pollution Control Agency and Reserve, but also to this Conference.

The First Annual Report of the White House Council on Environmental Quality was related by the President on Monday of this week. It notes the following, and I quote...

> "Section 21B of the new Water Quality Improvement Act of 1970 requires applicants for Federal permits to file with permit requests certification from the appropriate state or interstate pollution control agency that its activity will not violate water quality standards." End quote.

While this statement refers to new applicants for Federal permits, recent trends show Federal agencies look to the states for certification of compliance with state standards. Therefore, in the case of Reserve's discharge, it would seem vital that the Minnesota Pollution Control Agency know the court determination of whether the regulation in question--WPC-15 --is reasonable when applied to Reserve before the Agency can properly certify that Reserve meets or violates the standard if such certification should be required.

In evaluating the Conference record, it is respectfully suggested that analysis should include consideration of the significance in the lake of Reserve's discharge. On that premise it is submitted that the evidence does not show adverse effects on beneficial uses of the lake.

Reserve has undertaken the engineering studies referred to not because the lake is being harmed by the Company's present discharge system, but to determine if there is some other practical method or alteration which would relieve the concern some people have about the Company's use of the lake.

It is anticipated that by November 1, 1970, sufficient information will be available to permit the Company to assess any proposed alteration or modification from the viewpoint of sound conservation as well as technical and economic feasibility. The Company should be able to report to the Minnesota Pollution Control Agency as well as the Conferees its analysis and decision by December 1, 1970.

Reserve pledges continuing cooperation with the appropriate State and Federal agencies in attempting to arrive at an appropriate resolution.

Respectfully submitted,

Edward T Fride
Edward T. Fride
Attorney for Reserve Mining Company
1200 Alworth Building
Duluth, Minnesota

RESERVE MINING COMPANY
SILVER BAY, MINNESOTA 55614

E. M. FURNESS
PRESIDENT

July 29, 1970

Mr. John P. Badalich
Executive Director
Minnesota Pollution Control Agency
717 Delaware Street S. E.
Minneapolis, Minnesota 55440

Dear Mr. Badalich:

I acknowledge receipt of your letter of July 17th in which you refer to recommendations of the Lake Superior Conference and its reconvening on August 12th.

You state:

> "This matter, as I am sure you are aware of, is presently complicated by the current Court litigation now in progress in Two Harbors, Minnesota. Just recently I met with Mr. Ed Fride, your counsel, and Mr. Ed Schmid and we discussed this very matter and the advisability of discussing alternate methods *****. It was the consensus that this could not be accomplished at the present time because of the present Court litigation."

As you know, the Court action between Reserve and the PCA involves consideration of the reasonableness and validity of certain portions of the interstate water quality standard known as WPC-15 as applied to Reserve, as well as the counterclaim of the PCA requesting enforcement of the regulation against Reserve and a determination whether Reserve is in violation of certain Minnesota Statutes because of its discharge, with appropriate remedial action by the Court if such is its finding. Trial in that matter has been proceeding since June 22nd and is expected to be completed within the next few days. During the trial, many representatives of the Federal Water Quality Administration and the Interior Department, as well as the Minnesota Pollution Control Agency, have testified as to their views and appraisal.

Reserve has submitted evidence through some 15 witnesses including nationally renowned scientists who are intimately familiar with the discharge and the lake. Approximately 250 exhibits have been received by the Court thus far.

ATTACHMENT "A"

Evidence has also been submitted for the Court's consideration relating to possible alternative methods of tailings disposal and modifications in the present system.

We believe that the PCA as well as the Conferees should defer further consideration of possible alternate methods until all concerned have the benefit of the trial Court's evaluation of the entire situation and his decision on the several issues now pending before him.

You will recall that on January 26, 1970, Secretary of Interior Hickel issued his Summary of the Conference wherein he included in his recommendations that:

> "Reserve Mining Company be requested to undertake further engineering and economic studies relating to possible ways and means of reducing by the maximum practicable extent the discharge of tailings to Lake Superior and submit a report on progress to the Minnesota Pollution Control Agency and the Conferees within six months of the date of issuance of the Summary of Conference by the Secretary of the Interior."

Consistent with Reserve's Policy Statement issued prior to the Secretary's Summary and without waiving any question as to the jurisdiction of the Conference, Reserve has reported the progress of engineering and economic studies considering possible modifications of the present disposal system to the PCA on April 13, 1970, and to the Conferees on April 30, 1970. Some 19 tentative plans were reviewed and the agencies received current engineering reports on those occasions.

We are in the process now of testing and translating laboratory data and drafting board information into demonstrable, reliable information.

I mention jurisdiction because it is my understanding that the Federal Water Pollution Control Act requires that any conclusion of the Conference must be predicated on a proper finding that there is "pollution of waters which is endangering the health or welfare of persons in a state other than that in which the discharge originates," and also that any federal court in reviewing action taken subsequent to a Conference is charged with "giving due consideration to the practicability and to the physical and economic feasibility of securing abatement of any pollution proved, shall have jurisdiction to enter such judgment and orders enforcing such judgment, as the public interests and the equities of the case may require."

Notwithstanding the necessary involvement of Reserve's Research and Development staff in the current litigation, Reserve has continued to diligently explore possible modifications in association with the nationally-known consulting firms including further necessary tests and studies designed to provide the company with the necessary information upon which it can properly assess any proposed modification or alteration from the viewpoint of sound conservation as well as technical and economic feasibility. Information from these necessary preliminary studies is anticipated to be available by November 1, 1970. When we take cognizance of the fact that it took many years to plan and six years to construct the plant, the relatively short time requested to assess possible modifications seems most reasonable.

Since our last report to you, we have received the enclosed report from Arthur D. Little relating to "Analyses and Markets of Taconite Waste Products." As the engineering studies continue, we will report further progress to you.

I suggest that you consider submitting the additional report as well as copy of this letter to the other Conferees for their information and review. To facilitate such, additional copies of the report and this letter are attached.

Please be assured of our continuing desire to cooperate with the appropriate State and Federal agencies in arriving at an appropriate resolution of this situation.

Sincerely,

/s/ E. M. Furness

EMF/paa

8-10-70

RESERVE MINING COMPANY TAILINGS INVENTORY

A survey of the amount of tailings deposited in Lake Superior was completed on June 18, 1970. This survey accounted for 202.0 million long tons of tailings. Production records show that as of June 18, 1970, 205.1 million long tons of tailings have been discharged from the concentrating equipment. Drawings WA-13 and WA-14 show the distribution of these tailings.

It required one year to obtain all of this data, June 17, 1969, to June 18, 1970. The last date that any data was obtained, June 18, 1970, was selected as the most conservative date to examine the production records for determination of the total amount of tailings discharged, 205.1 million long tons, to compare to the inventory, 202.0 million long tons. Much of the difference, 3.1 million long tons, can be accounted for by the unmeasured increase of the tailings deposit during the year's time the data was being gathered, tailings used on highways, used by Reserve during construction of their plant expansion, other miscellaneous uses, and that hauled out as oversize material.

The complete tailings inventory accounted for 98.5% of the tailings discharged up to and including the last day of data collection. It also shows that 90.7% of the tailings inventory was deposited within the nine square mile discharge zone.

Surveys by Reserve's Engineering Department completed a physical survey of the delta above the lake level on June 18, 1970. This data, elevations of the lake bottom of this area before operations were started, and bulk density of samples of tailings from the delta were used to establish that the delta to the water's edge contained 64.9 million long tons of tailings.

Twenty transects were made with the Research launch, "Alma," (June 16-17-18, 1970) from the water's edge of the delta to a tailings depth of approximately 55 feet. The bottom depth was determined with the Raytheon DE-72B depth sounder. The position of the launch was verified by the engineering survey crew from fixed positions on shore. The depth of tailings was determined by subtracting the depth of the lake bottom found in this area from that determined before the plant started operations. This accounted for 63.3 million long tons of tailings. Normally, this is considered the toe of the delta.

The area of tailings depth from 3 feet to 55 feet was surveyed using an acoustic sub-bottom profiling system rented from Hydro Products Division of the Dillingham Corporation. This survey was made from June 1 through June 10, 1970. The Research launch's position was accurately established by the Engineering Department survey crew while tailings depth measurements were made at 802 points. This area accounted for 43.0 million long tons of tailings.

Attachment B

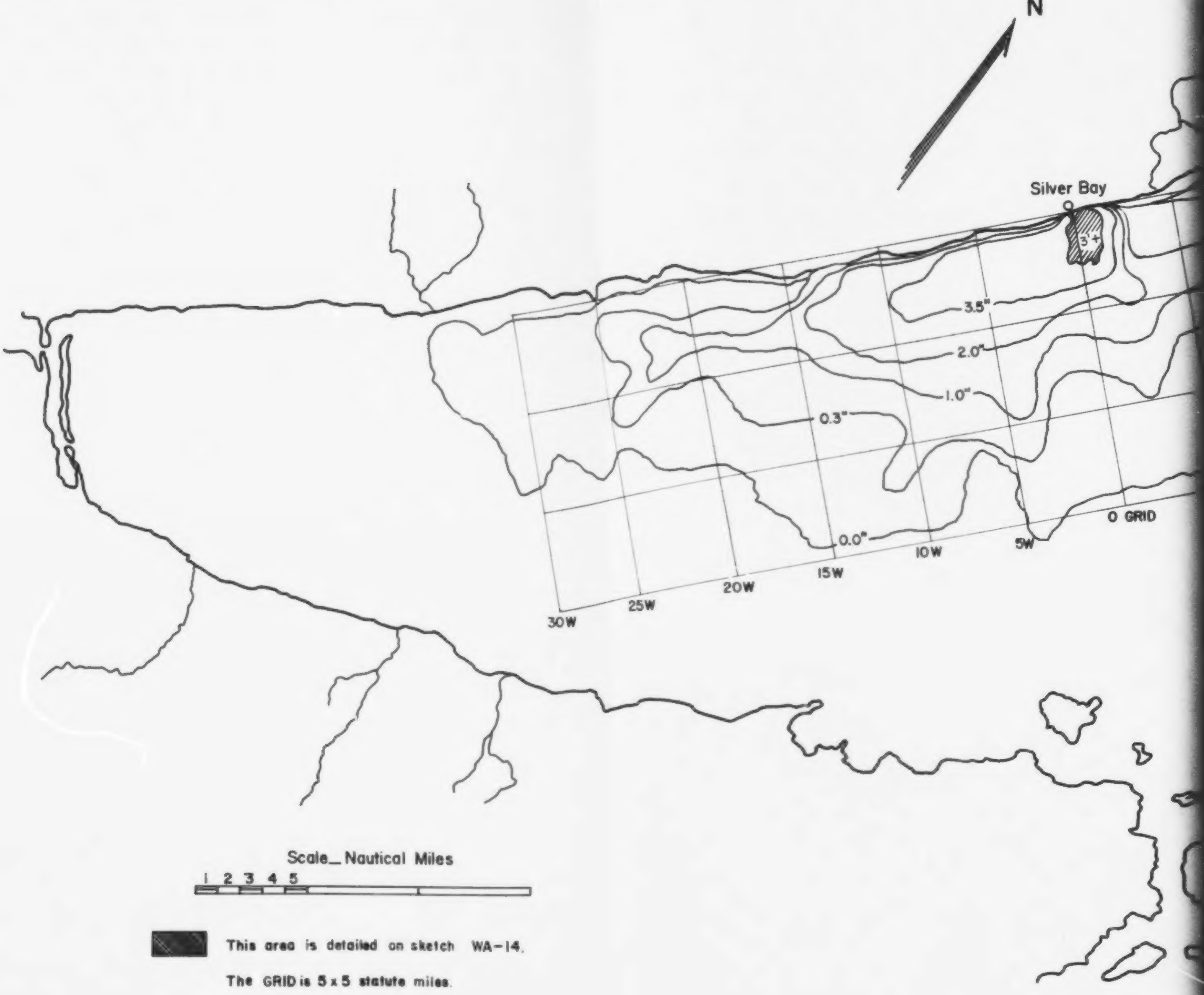
The balance of the tailings deposit was established by 125 bottom samples secured with a Pfleger gravity sediment corer from June 17, 1969 to December 11, 1969. The thickness of apparent tailings on the top of the cores was carefully measured. The thickness of the apparent tailings layer was established by taking X-ray pictures of each core. The apparent tailings layer was then analyzed by X-ray diffraction using a Norelco diffractometer. If this X-ray diffraction analysis showed the presence of cummingtonite, then the apparent tailings layer and the natural bottom sediments were each analyzed for titanium. The amount of tailings present in the apparent tailings layer is calculated using these titanium analyses.

The zero tailings isopach line was established as half the distance between the last core sample which had a top layer of tailings identifiable on the X-ray film, verified as tailings by X-ray diffraction and titanium analysis, and the next point that a core was taken that did not show such a tailings layer.

The tailings outlined by these bottom core samples accounted for 30.8 million long tons of tailings.

The weight for unit volume of tailings in various areas of the tailings deposit was determined by obtaining 28 bottom sediment cores with the Pfleger sampler. The volume of tailings in each sample was carefully measured, then dried and weighed.

ISOPACH of APPROXIMATE DISTRIBUTION of F
TAILINGS DEPOSIT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30W

Scale_ Nautical Miles

1 2 3 4 5

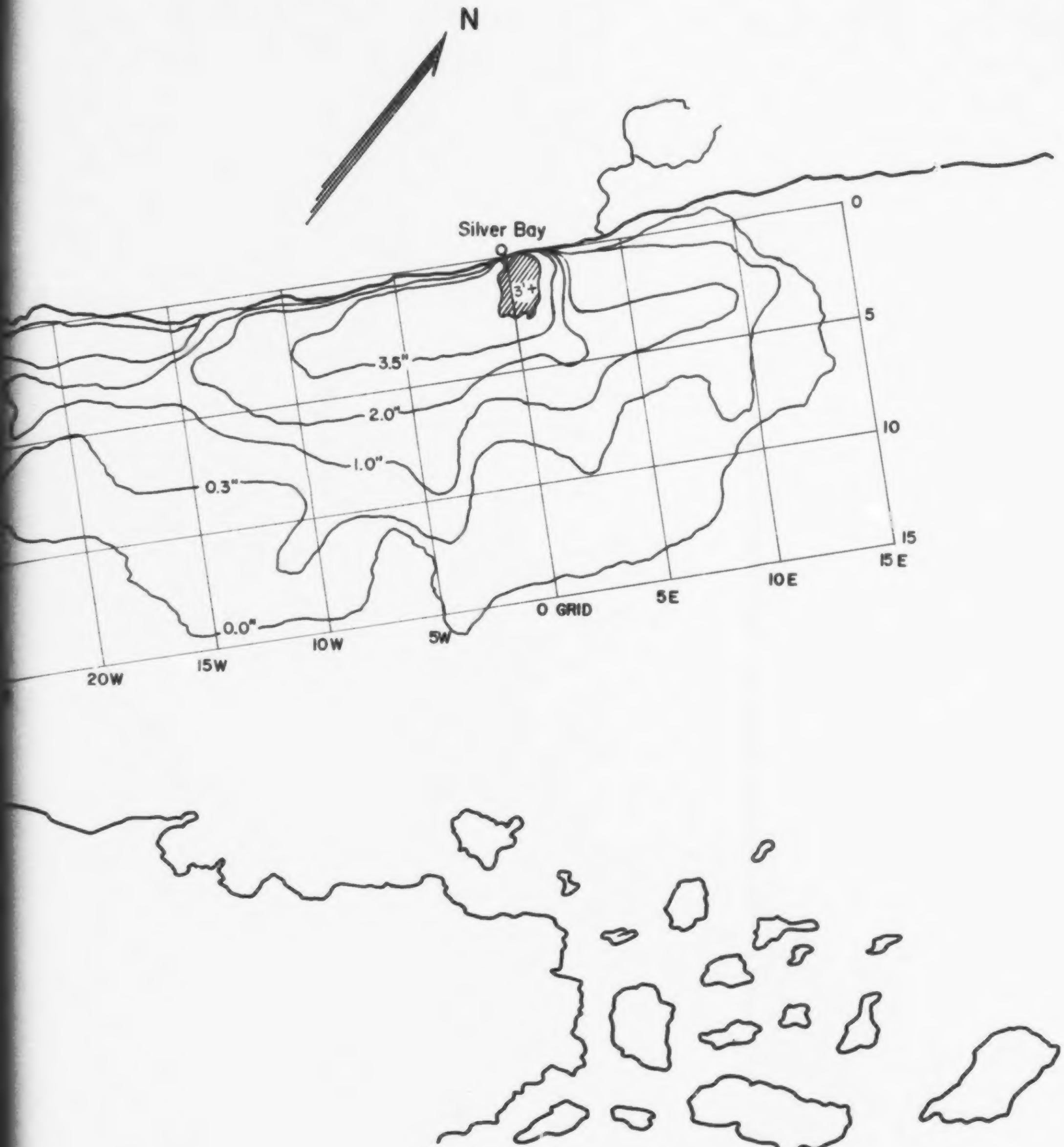
▨ This area is detailed on sketch WA-14.

The GRID is 5 x 5 statute miles.

This map was derived from U.S. ARMY
CORPS of ENGINEERS Chart No. 96 and 97.
(72 % of chart size)

A

MATE DISTRIBUTION of FINE
NGS DEPOSIT



AUG 11 1970

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RESERVE MINING COMPANY

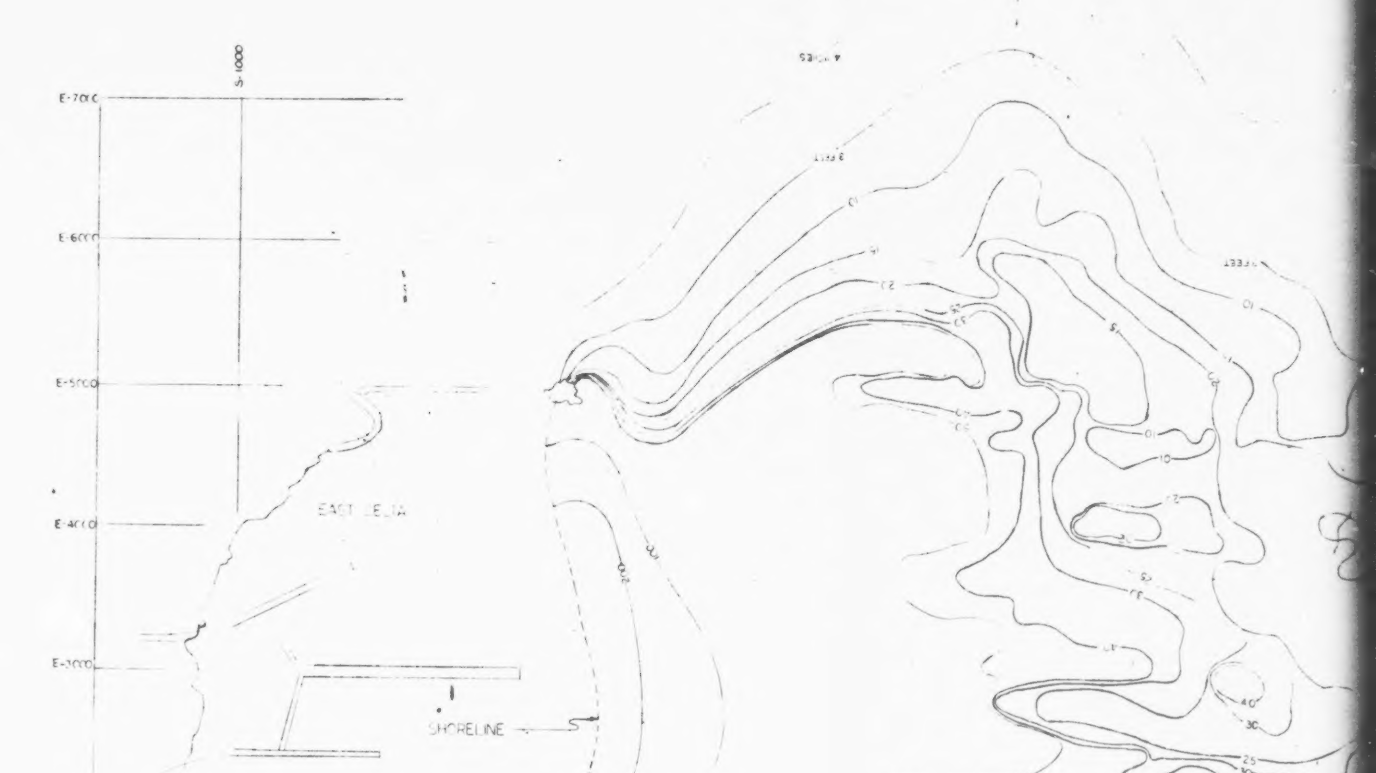
ISOPACH OF APPROXIMATE DISTRIBUTION
OF FINE TAILINGS DEPOSIT

6-27-70
DATE

BY E. Johnson
APPR.

WA-13

B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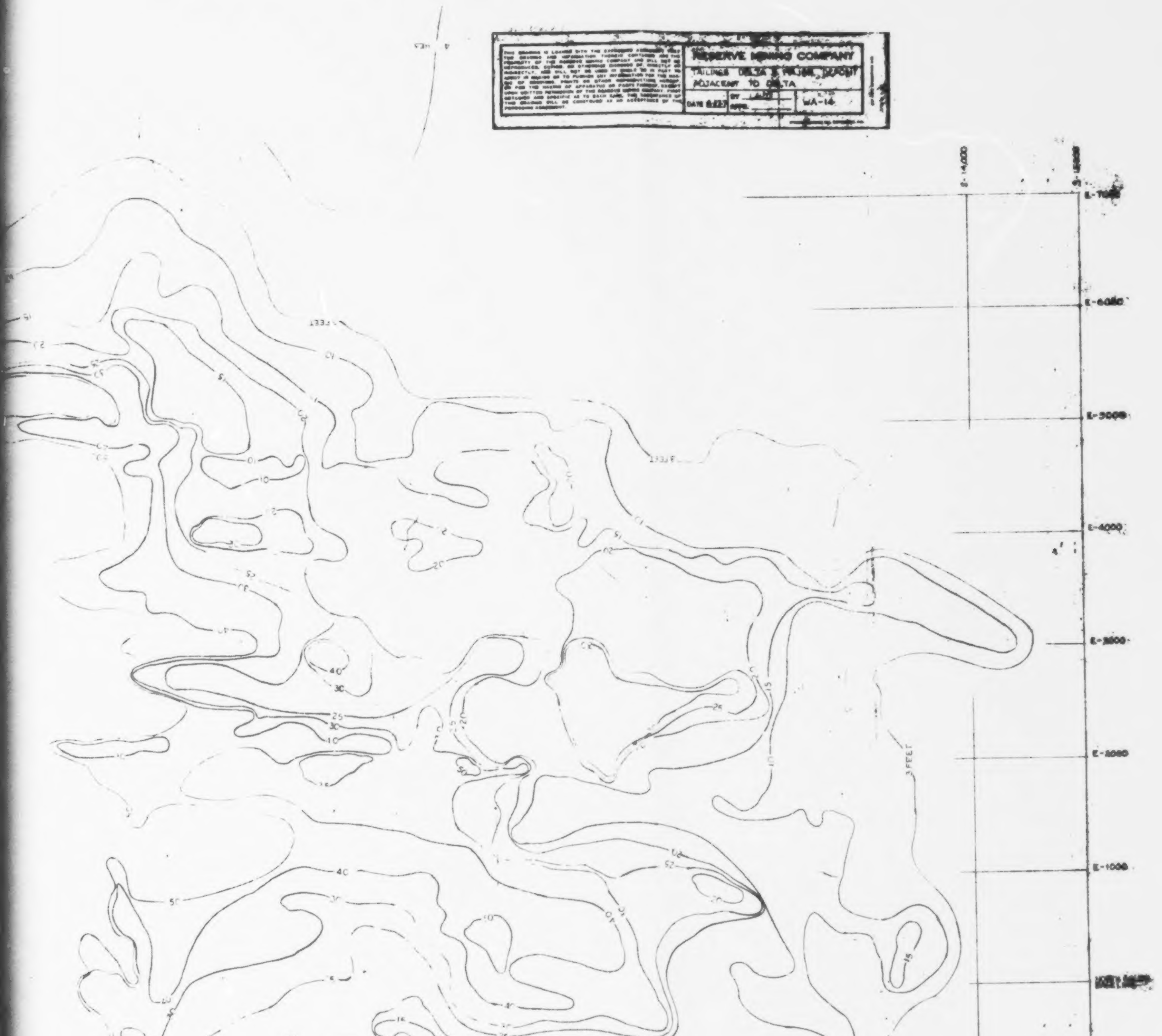
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RESERVE MINING COMPANY
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WA-14

AUG 1 1 1978

B

RESERVE MINING COMPANY

MEMORANDUM

TO E. M. Furness

DATE August 10, 1970

FROM K. M. Haley

SUBJECT Engineering Task Force Activities to Date

On September 2, 1969, Reserve Mining Company issued a policy statement announcing the formation of an Engineering Task Force to investigate possible modification or alteration of its present tailings disposal system. The Task Force included engineers and scientists from Reserve and representatives of Reserve's shareholders. They retained engineers and specialists from the highly-respected, nationally-known consulting firms of Bechtel Corporation, San Francisco, California; Engineering-Science, Inc., Arcadia, California; Arthur D. Little, Inc., Cambridge, Massachusetts; Parsons-Jurden Corporation, New York, New York; and Trygve Hoff & Associates, Cleveland, Ohio, to study alternate methods of tailings disposal.

These consultants and members of the Task Force made a careful analysis and inspections of the plant and, subsequently, their engineering reports and a summary of progress was submitted to the Minnesota Pollution Control Agency and the conferees.

This memorandum briefly indexes the continuing activities of the Task Force from January 20, 1969, to date.

January 20-24, 1969 - Meeting with Trygve Hoff & Associates engineers. Requested that they prepare preliminary engineering studies on disposing of total tailings by pumping to an inland site.

February 17-18, 1969 - Meeting with Trygve Hoff & Associates engineers. Reviewed engineering progress. Also requested that they prepare preliminary engineering studies on transporting total tailings by railroad and disposing them at a site near the mine.

March 10-11, 1969 - Meeting with Tryve Hoff & Associates engineers. Reviewed the status of engineering.

March 31-April 1, 1969 - Meeting with Tryve Hoff & Associates engineers. Reviewed final draft of Report #1, "Pumped Inland Disposal to Settling Basin," and progress of engineering on their Report #2, "Overland Disposal by Railroad."

Attachment C

April 7, 1969 - Trygve Hoff & Associates submitted their Report #1, "Pumped Inland Disposal to Settling Basin."

April 14-16, 1969 - Meeting with Trygve Hoff & Associates engineers. Reviewed the status of engineering on their Report #2.

May 6-7, 1969 - Meeting with Trygve Hoff & Associates engineers. Reviewed the status of engineering and the preliminary draft of their Report #2.

May 28, 1969 - Meeting with Republic, Armco, Reserve and Trygve Hoff & Associates engineers. Requested that Trygve Hoff & Associates prepare preliminary engineering studies on the disposal of fine tailings only.

June 18-20, 1969 - Meeting with Republic, Armco, Reserve, and Trygve Hoff & Associates engineers. Reviewed the status of engineering.

July 30, 1969 - Meeting with Republic, Armco, Reserve and Trygve Hoff & Associates engineers. Reviewed the status of engineering. Requested that Trygve Hoff and Associates prepare preliminary engineering studies on the disposal of total tailings under a protective curtain.

September 3, 1969 - Meeting with Engineering Science, Inc., representative. Requested that they prepare preliminary engineering studies on alternate methods of tailings disposal.

September 11, 1969 - Meeting with Bechtel Corporation engineers. Requested that they prepare preliminary engineering studies on alternate methods of tailings disposal.

October 1-2, 1969 - Meeting with Engineering Science, Inc., representatives. Reviewed the status of their engineering studies.

October 7, 1969 - Meeting with Republic, Armco, Reserve and Trygve Hoff & Associates engineers. Reviewed the status of engineering.

October 20, 1969 - Meeting at Bechtel Corporation's San Francisco office to review their engineering progress to date.

October 29-31, 1969 - Meeting with Bechtel Corporation engineers. Reviewed the status of engineering progress to date.

November 4-5, 1969 - Meeting with Engineering Science, Inc., representatives to review the status of their engineering studies.

November 10-11, 1969 - Meeting of Republic, Armco and Reserve engineers to review the status of engineering on alternate methods of disposal.

November 17-19, 1969 - Meeting with Trygve Hoff & Associates engineers. Reviewed final drafts of their reports. Requested that they review their Report #1 again.

November 19, 1969 - Meeting with Arthur D. Little, Inc., representatives. General review of taconite tailings for possible market analysis.

November 19-20, 1969 - Meeting with Parsons-Jurden Corporation engineers. Requested that they prepare preliminary engineering studies on alternate methods of tailings disposal.

December 4-5, 1969 - Meeting with Tryve Hoff & Associates engineers. Discussed piping tests for tailings pipeline design.

December 16, 1969 - Trygve Hoff & Associates submitted their final Report #3, "Disposal of Fine Tailings Only in the Lax Lake Area," and Report #4, "Fine Tailings Disposal by Deep Pipe into Lake." They also submitted a final draft of their Report #5, "Marine Curtain."

December 17-19, 1970 - Meeting with Parsons-Jurden Corporation engineers. Reviewed the status of engineering on their tailings disposal work.

December 29, 1969 - Tryve Hoff & Associates submitted their final Report #2, "Overland Disposal by Railroad."

January 7-9, 1970 - Meeting with Trygve Hoff & Associates engineers. Reviewed their Report #5, "Marine Curtain," Reserve's Proposal #5, "Tailings Disposal Under a Protective Curtain."

January 8, 1970 - Meeting with Bechtel Corporation engineers to review drafts of their reports.

January 12, 1970, Meeting with Bechtel Corporation engineers to review drafts of their final reports.

January 28, 1970 - Submitted report, "Status of Engineering Task Force on Alternate Methods of Tailings Disposal."

January 28, 1970 - Meeting with Parsons-Jurden Corporation engineers. General discussion on tailings disposal studies.

February 4, 1970 - Bechtel Corporation submitted their report, "Tailings Transportation and Impoundment," in four volumes--"Coarse Tailings by Railroad to Site - Lax Lake, Fine Tailings by Pipeline to Site 4 - Lax Lake"; "Coarse Tailings by Belt Conveyor to Site 4 - Lax Lake, Fine Tailings by Pipeline to Site 4 - Lax Lake"; "Coarse Tailings by Railroad to Site 7 - Mile 32, Fine Tailings by Pipeline to Site 4 - Lax Lake"; and "Appendix."

February 4, 1970 - Trygve Hoff & Associates submitted their Revised Report #1, "Pumped Inland Disposal to Settling Basin," Reserve's Proposal #1, "Total Tailings Disposal in Lax Lake Area."

February 6, 1970 - Arthur D. Little, Inc., proposal submitted.

February 9, 1970 - Meeting with Engineering Science representatives. Progress report on their engineering.

February 12-13, 1970 - Meeting of Republic, Armco and Reserve engineers to review the status of engineering on alternate methods of tailings disposal.

February 16-17, 1970 - Meeting with Parsons-Jurden Corporation engineers. General discussions and progress review of their tailings disposal suggestions.

February 19, 1970 - Meeting with Trygve Hoff & Associates engineers. Presented all available information to them on dry cobbing. Requested preparation of preliminary engineering studies.

February 20, 1970 - Purchase Order #75-31701 issued to Arthur D. Little, Inc., for study on "Analysis and Markets of Taconite Waste Products."

February 20, 1970 - Meeting with Engineering Science representative. Discussed progress to date on their engineering.

February 24, 1970 - Meeting at Parsons-Jurden Corporation's New York office to review their engineering progress to date.

March 2-5, 1970 - Series of meetings with Trygve Hoff & Associates engineers to review three potential plans of installing equipment.

March 4, 1970 - Parsons-Jurden Corporation submitted their report, "Study of Disposal of Thickened Tailings at the Lake Shore."

March 10, 1970 - Parsons-Jurden Corporation submitted their report, "Study of Controlled Deposition of Thickened Tailings Below the Lake Surface."

March 12, 1970 - Meeting of Republic, Armco and Reserve engineers to review the status of engineering on alternate methods of tailings disposal.

March 16, 1970 - Trygve Hoff & Associates submitted their revised Report #5, "Tailings Disposal Under a Protective Curtain."

March 17, 1970 - Parsons-Jurden Corporation submitted their report, Study of Tailings Disposal by Impoundment Adjacent to Plant Site."

March 18-19, 1970 - Meeting with Trygve Hoff & Associates engineers to review their engineering progress.

March 30, 1970 - Meeting with Parsons-Jurden Corporation engineers. Final review of reports submitted to date.

April 7-8, 1970 - Meeting with Trygve Hoff & Associates engineers. Reviewed their engineering to date.

April 9-10, 1970 - Meetings with Parsons-Jurden Corporation engineers. Presented them with all available information to date. Requested them to promptly prepare preliminary engineering on methods of disposing of dry cobber tailings.

May 4-5, 1970 - Meetings with Parsons-Jurden Corporation engineers. Reviewed their progress to date on developing methods of disposal.

May 7-8, 1970 - Meeting with Trygve Hoff & Associates engineers for review of their engineering.

May 14, 1970 - Meeting with Parsons-Jurden Corporation engineers. Discussed alternate location of dry cobbing plant. Requested them to promptly prepare a preliminary engineering study of dry cobbing as a separate operation between the crushing and concentrating steps.

May 27, 1970 - Meeting at the New York office of Parsons-Jurden Corporation. Preliminary review of engineering progress.

June 3, 1970 - Meeting with Arthur D. Little, Inc., engineers to review a draft of their report.

June 4-6, 1970 - Meeting with Trygve Hoff & Associates engineers. Reviewed draft of final report, "Reserve Mining Company Dry Cobbing Process."

June 9-10, 1970 - Meeting of Republic, Armco and Reserve engineers to review the status of alternate methods of tailings disposal engineering.

June 15-16, 1970 - Meeting with Parsons-Jurden Corporation engineers to review preliminary layouts.

June 15, 1970 - Trygve Hoff & Associates' report, "Reserve Mining Company Dry Cobbing Process," submitted.

June 18-19, 1970 - Meeting with Parsons-Jurden Corporation engineers. Discussion on engineering progress to date on the development of methods of tailings disposal.

June 29-30, 1970 - Meeting with Parsons-Jurden Corporation engineers to review their final report, "Dry Cobbing Separation Plant."

July 13-14, 1970 - Meeting of Republic, Armco and Reserve engineers to review the status of engineering of alternate methods of tailings disposal.

July 30-31, 1970 - Meeting of Republic, Armco and Reserve and Parsons-Jurden Corporation engineers to review Parsons-Jurden's engineering work to date.

KMHaley

K. M. Haley
Vice President and Manager - R & D

KMH:sb

RESERVE MINING COMPANY

MEMORANDUM

TO E. M. Furness

DATE August 6, 1970

FROM K. M. Haley

SUBJECT Tailings - R & D Pilot Plant

Attached is a chronological summary of Reserve's Research and Development pilot plant activities and progress investigating various proposals related to alteration and/or modification of our tailings handling and disposal method.

It attempts to itemize efforts to test and translate proposed engineering concepts to pilot plant operation and includes references to specific problem areas discovered, some necessary equipment acquisitions, research conferences and overall progress.

K. M. Haley
Vice President and Manager - R & D

KMH:sb
Enc.

Attachment D

CHRONOLOGICAL LISTING OF ACTIVITIES
TAILINGS PROCESSING TESTS

October 7, 1969 - Trygve Hoff & Associates requested that Reserve enlarge their planned pilot plant tailings thickening study to include tests that would produce basic engineering data which they needed.

October 10, 1969 - P.O. #14585 - Harold Beck - Electric actuator for tailings pump drive.

October 15, 1969 - Work Order #4269 - Install tailings pump, thickener, splitter, instrumentation, flocculant feeders and related steel work for pilot plant tailings test.
P. O. #14586 - W. S. Nott - Gear reducer for total tailings pump.

October 15, 1969 - Trygve Hoff & Associates' "Tailings Separation Test" proposal submitted to Reserve.

October 16, 1969 - P.O. #14584 - Red Valve Co. - Eccentric reducer for total tailings pipe.
P.O. #14582 - Continental Sales - A-S-H total tailings pump

October 17, 1969 - P.O. #14583 - W. S. Nott - 100' 10" dia. rubber tailings pipe.
P.O. #14537 - Continental Sales - Gyrol fluid drive for total tailings pump

October 22, 1969 - Drawing #28-1148 - Outside Thickener - Structural Steel

November 6, 1969 - Drawing #28-4406 - Details - Total Tailings Splitter
Drawing #28-4405 - Total Tailings Splitter

November 7, 1969 - Drawing #28-4404 - Total Tailings Bypass Launder
Drawing #28-4402 - Total Tailings Bypass Launder
Drawing #28-4403 - Total Tailings Bypass Launder

November 10, 1969 - Drawing #28-4421 - Elevation View at Total Tailings Thickener
Drawing #28-4412 - Plan View Total Tailings Thickener
Drawing #28-4417 - Section C-C - Drawing #4412
Drawing #28-4415 - Section B-B - Drawing #4412
Drawing #28-4414 - Section A-A - Drawing #4412

November 11, 1969 - Drawing #28-4407 - Total Tailings Pump Base

November 12, 1969 - Drawing #28-4408 - Total Tailings Splitter

November 14, 1969 - Drawing #28-4409 - Total Tailings Junction Box Door
Drawing #28-4410 - Total Tailings Junction Box Door
Drawing #28-4411 - Total Tailings Junction Box Door

November 16, 1969 - Drawing #28-4422 - Outside Thickener Overflow Piping
Drawing #28-4423 - Outside Thickener Overflow Piping

November 17, 1969 - Drawing #28-4424 - Flocculant Tank Layout

November 17-18-19, 1969 - Trygve Hoff & Associates' engineers reviewed R & D plans of tailings separation tests with R & D personnel. Report issued on agreed upon test procedures.

November 19, 1969 - Reviewed pilot plant tailings separation test plans with Engineering Science, Inc., engineer. He recommended more retention time between flocculant addition and the clarifiers. Such equipment will be designed and installed for testing.

November 20, 1969 - Letter - K. M. Haley, Reserve Mining Company, to Bob Evans, Dings Magnetic Separator Company.
Contents: K. M. Haley accepts Dings offer to loan Reserve Mining Company an experimental dry cobber for pilot tests.

November 24, 1969 - Drawing #28-4418 - Overflow Outlet - Total Tailings
Drawing #28-4425 - Layout - Total Tailings Pump
Drawing #28-1149 - Outside Thickener Stairs

November 25, 1969 - Drawing #28-1150 - Outside Mixing - Holding Tank

November 25, 1969 - Letter - Bob Evans, Dings Magnetic Separator Company, to K. M. Haley, Reserve Mining Company.
Content: Dings state that experimental dry cobber is at the Mines Experiment Station. It won't be available for Reserve tests until February, 1970.

December 4-5, 1969 - Trygve Hoff & Associates' engineers ask that R & D develop pipe friction and velocity requirement data for tailings.

December 8, 1969 - P.O. #17066 - Modern Construction - Tailings pump feed pipe.

December 19, 1969 - Planning Meeting
Reviewed operations for the week of December 22, 1969. The main purpose of testing will be to check out the pilot plant thickener-clarifier tailings circuit. Will use water to test the system.

December 26, 1969 - Planning Meeting
Reviewed operations for the week of December 29, 1969. Testing will be concentrated on the tailings thickener and clarifiers. Some problems were encountered with wiring instrumentation for the tailings test circuit. Operating procedures were reviewed.

January 2, 1970 - Planning Meeting
Reviewed operations which are to start on January 4, 1970. When the plant starts, it will continue to operate on a 24-hour, seven-days-a-week basis for the next two months. Main purpose of testing will be to develop engineering data on tailings characteristics.

January 9, 1970 - Planning Meeting
Tailings tests started on January 4, 1970. Plant is operating on a seven-days-a-week, 24-hours-per-day schedule. The previous week's test was used to evaluate sampling procedures and to gather basic data. The thickener underflow pipes kept plugging. The underflow pipes were revised to eliminate the problem.

January 9, 1970 - Work Order #40137 - Remove double deck screen from Babbitt Pilot Plant
P.O. #17927 - Terminal Electric - Tailings pump starter

January 14, 1970 - P.O. #18543 - Vibra Screw Feeder Co. - Feeder screw for volumetric feeder.

January 16, 1970 - Planning Meeting
The past week's work evaluated the tailings thickener. Underflow percent solids was varied. Different flocculants were tested in the clarifiers.

January 23, 1970 - Planning Meeting
The thickener tests were completed. Clarifier tests started immediately. The Pilot Plant operation continues on a 7-days-per-week, 24-hours-per-day basis. A planning session was held.

January 29, 1970 - Work Order: 40150 - Install double deck screen ahead of rod mill.
P.O. #19408 - W. S. Tyler Co. - Vibrating screen cloth for rod mill screen.

January 30, 1970 - Planning Meeting
Results of the thickener tests were reviewed. Clarifier tests are in progress. Various feed rates are being run through the tailings clarifier system. The Pilot Plant was shut down several times during the week because of plugged pumps. The circuit is being revised to eliminate the plugging.

Dry cobbing and screening prior to the rod mill test plans were reviewed. The experimental dry cobber arrived this week. The rod mill vibrating screen arrived from Babbitt. The Maintenance Department is rebuilding the screen.

January 30, 1970 - P.O. #18917 - Falk Corp., - Gears for tailing pump gear reducer.

February 4, 1970 - Work Order: 40158 - Install dry cobber in Pilot Plant
P.O. #1944 - Arrowhead - Tailing clarifier rake drive parts.

February 6, 1970 - Planning Meeting
Tailings separation tests were reviewed. Testing continued both on the thickener and clarifiers. Mechanical revisions were required to extend the test range.

February 10, 1970 - Drawing No. 28-4467 - Rod mill trommel with screen.
Drawing No. 28-4468 - Screen splash guard.

February 13, 1970 - Planning Meeting
Tailings separation tests were reviewed. Overflow problems resulting from higher feed rates to the thickeners were corrected. The thickener rakes were jammed several times during the week.

February 16, 1970 - Drawing No. 28-4469 - Dry cobber fabrications.
P.O. #19444 - Arrowhead Bearing - Sprockets for tailings clarifier drives.

February 20, 1970 - Drawing No. 28-4470 - Dry cobber fabrications.

February 20, 1970 - Planning Meeting
Tailings separation tests continue. Clarifier flocculant evaluation is in progress. Dry cobber drawings issued for fabrication.

February 25, 1970 - Work Order: 40175 - Remove two hydroseparators from Babbitt Pilot Plant.

February 27, 1970 - Planning Meeting
The two-month continuous tailings test is completed. Tailings separation tests are to continue. Various flocculants which can be used in the clarifiers will be evaluated.

The rod mill vibrating screen drawings were issued for fabrication.

Tailings pumping tests are in progress. Having trouble with the tailings pump plugging. The test loop will be rebuilt to eliminate the problem.

Preliminary project plan for dry cobbing of rod mill feed was reviewed. Operating procedures and potential safety hazards were detailed and investigated. Tests are scheduled to start March 8.

March 3, 1970 - P. O. #20693 - Zalk-Josephs - Fabricate steelwork for tailings thickeners

March 4, 1970 - Drawing No. 28-4472 - Shaking screen frame location
Drawing No. 28-4473 - Shaking screen frame details
Drawing No. 28-4474 - Shaking screen frame details
Drawing No. 28-4475 - Shaking screen undersize pan

March 5, 1970 - Drawing No. 28-4476 - Shaking screen oversize catch pan
Drawing No. 28-4477 - Rod Mill feed chute

March 6, 1970 - Planning Meeting
Tailings separation tests are scheduled to start on March 8. The pilot plant was shut down this week to install equipment.

March 9, 1970 - Drawing No. 28-4480 - Dry cobber chain guard

March 13, 1970 - Planning Meeting
Operational problems prevented effective tailings separation tests this week.

Sampling problems were caused by the physical layout of the cobbing separator. The dry cobber tailings chute kept plugging. The installation will be revised to eliminate the problems. Tests showed that there is an interaction between several variables involved in the dry cobbing operation.

March 17, 1970 - Drawing No. 28-4478 - Rod mill feed chute stand
Drawing No. 28-4500 - Revised R & D total tailings splitter.

March 18, 1970 - Drawing No. 28-4479 - Shaking screen belt guard
Drawing No. 28-4499 - Shaking screen feed chute
Work Order #40197 - Fabricate scale calibration boxes for dry cobber scales

March 19, 1970 - Work Order #4278 - Install steel work, splitter, pumps, piping, thickeners, instrumentation, and related equipment for lakeside tailings pumping test.

March 20, 1970 - Drawing No. 28-4498 - Shaking screen assembly
Drawing No. 28-4501 - Layout of R & D total tailings thickener feed pipe

March 20, 1970 - Planning Meeting
The dry cobber was alternated in and out of the circuit during the past week. Data was analyzed. Still had problems with the tailings chute

being plugged. Further revision will be required before operating the dry cobber continuously.

Tailings separation tests continue. Various flocculants were evaluated.

March 21, 1970 - Drawing No. 28-4502 -Layout of R & D total tailings thickener overflow pipes.

March 24, 1970 - Drawing No. 28-4496 - Shaking screen oversize piping.
Drawing No. 28-4497 - Shaking screen undersize sample box.

March 24, 1970 - Work Order: 40202 - Install new tailings launder to east side of Pilot Plant.
P.O. #21833 - Modern Construction - Fabricate elbows for tailings line

March 26, 1970 - Planning Meeting
Dry cobbing and tailings separation tests continue.

The vibrating screen is being installed ahead of the rod mill this week.

March 28, 1970 - Drawing No. 28-4486 - Rod mill discharge catch box.

March 30, 1970 - Drawing No. 28-4486 - Rod mill sump and pump layout.
Drawing No. 28-4484 - Rod mill sump and pump elevation. (looking East)
Drawing No. .28-4485 - Rod mill sump and pump elevation. (looking North)
Drawing No. 28-4487 - Rod mill discharge sample box.
Drawing No. 28-4488 - Details of rod mill sump.
Drawing No. 28-4489 - Piping of finisher conc. to flotation cell.
Drawing No. 28-4490 - Rod mill to shaking screen (piping).

March 31, 1970 - P.O. #22208 - Zalk Joseph - Fabricate slurry tank for tailings test.

April 2, 1970 - Drawing No. 28-4503 - Layout of thickener platforms.

April 2, 1970 - P.O. #21846 - Armco Steel - 26 tons 1-1/2" diameter grinding balls for experimental grinding circuit test.

April 3, 1970 - Planning Meeting

Rod mill feed was screened at 6 mesh, Rod mill was operated in open circuit. Various operational problems prevented the screen from performing as desired. The plant was shut down several times during the week to revise the system. Further modifications are scheduled.

Two additional tailings thickeners are being installed.

April 3, 1970 - P.O. #22259 - Continental Sales - Ship 3 special order tailings pumps - shipped air freight - truck strike.
P.O. #22260 - Crinnell Co. - 3500 feet of 3-inch diameter tailings test pipe.

April 4, 1970 - Drawing No. 28-4462 - Primary screens overflow to ball mills (piping).
Drawing No. 28-4463 - Primary scalping overflow to primary finishing (piping).
Drawing No. 28-4464 - Primary screens overflow splitter.

April 7, 1970 - Drawing No. 28-4504 - Concrete slab layout of sump and pump anchor bolts.
P.O. #22261 - Grinnell Co. - Roustabout couplings for 3500 feet of tailings pipe.
P.O. #22282 - Arrowhead Supply - Sprockets for tailings thickener rake drives.

April 8, 1970 - P.O. #22502 - Dorr Oliver - Rod mill screen - shipped air freight - truck strike.

April 9, 1970 - Drawing No. 28-4505 - Details of Drawing No. 28-4504.
Work Order: 40215 - Install closed circuit pump at rod mill.
P.O. #22262 - Vermillion Equipment - 4 - 10' rubber hose sections for tailings test. Delayed delivery 2 months because of rubber workers' strike.
P.O. #22511 - W. F. Hartfiel Co. - Pressure alarms - Tailings pumping test.
P.O. #22513 - W. S. Nott - Rod mill screen pump discharge hose.
P.O. #22515 - Grinnell Co. - Flotation buoys for tailings test.
P.O. #22516 - Westinghouse - 3 tailings pump motors held up by truck strike - delivered air freight.
P.O. #22519 - Arrowhead Bearing - Pump sheaves - tailings pumps.
P.O. #22522 - Strux Corp. - Flotation collars for tailings pipe - delayed 15 days by truck strike.

April 10, 1970 - Work Order: 40216 - Move electronic flowmeters to screen feed lines.

April 10, 1970 - Planning Meeting

The rod mill screen tests continue. We decided that the open circuit rod mill screen wouldn't work. The test was abandoned.

Flocculant tests continued in tailings circuit. Several more flocculants were evaluated.

April 10, 1970 - Drawing No. 28-4506 - Location of underflow 3-stage pumping slab.
Drawing No. 28-4509 - Layout of 3-stage 3" Ø A.S.H. A-6-5 pumps.

April 12, 1970 - Drawing No. 28-4535 -- Dry cobber frame.
Drawing No. 28-4518 -- DSM Screen sample box.

April 13, 1970 - Drawing No. 28-4516 - DSM screen location plan view.

April 14, 1970 - Drawing No. 28-4517 - DSM screen location elevation
Drawing No. 28-4508 - A.S.H. pump motor base (A frame) R & D total tailings test.
P.O. #22546 - Anderson Crane - Pump sheaves - rod mill screen pump.
P.O. #22573 - Mars Co. - Swivels - flotation buoys - tailings pipeline test.

April 15, 1970 - Drawing No. 28-4519 - DSM screen piping.

April 16, 1970 -- Drawing No. 28-4509 - Revision of R & D 10' rougher.
Work Order: 40221 - Rotate R & D 10' rougher 180°. Reinstall automatic splitter.
P.O. #22576 - Northern Electric - Electrical wire - tailings test.
P.O. #22578 - Penberthy Co. - Eductors - tailings flocculant test.
P.O. #22907 - Duluth Tent & Awning - Flotation bags - tailings pipeline test.

April 17, 1970 - Planning Meeting
Dry cobbing tests continue.

Close-circuit screening around the rod mill was installed and evaluated. The plant was operated intermittently during the week. Plugging pumps and overloaded grinding mills prevented the tests from being successful.

April 17, 1970 - Drawing No. 28-4510 - Revision of R & D cobber concentrate launder.

April 20, 1970 - Work Order: 40224 - Install fine screen piping in ball mill circuit.
P.O. #22582 - Dings Magnetic - Dry cobbing drum - Delivery delayed 2 months by truck strike.

April 22, 1970 - Work Order: 40228 - Install Dorr Oliver screen in rod mill recirculating circuit.
Work Order: 40227 - Revise fine screen distribution box.
Drawing No. 28-4542 - Lowering of R9C steel and stairs.

April 23, 1970 - Drawing No. 28-4543 - Stairway 700'-8" to 694'-6".

April 24, 1970 - Planning Meeting
All tests continue.

The rod mill vibrating screen test was abandoned early in the week. Operating problems prevented the circuit from performing as desired. The rest of the week was used to install a stationary curved rod mill screen.

Fine screens were installed in the ball mill circuit in place of the ball mill cyclones. The rod mill screen underflow was sent directly to the rougher magnetic separator. The cobber magnetic separator was removed from the circuit. These revisions are necessary to utilize the increased grinding which was obtained at the rod mill.

Tailings separation tests continued in the thickeners and clarifiers.

April 25, 1970 - Drawing No. 28-4511 - Recycling siphonsizer and finisher tailings in R & D Pilot Plant circuit.
Drawing No. 28-4512 - Section A-A through F-F of Drawings No. 28-4511.
Drawing No. 28-4537 - R9C take-up layout and steel detail.
Drawing No. 28-4538 - R9C take-up guard.

April 27, 1970 - Drawing No. 28-4540 - R9C Counterweight.

April 28, 1970 - Work Order: 40229 - Install flat deck rod mill screen.
Drawing No. 28-4491 - Layout of 60 Hp. rod mill pump motor.

April 29, 1970 - Drawing No. 28-4539 - R9C take-up idlers.

April 30, 1970 - Work Order: 40232 - Revise fine screen circuit piping.
P.O. #23505 - Krebs Engineers - Ball mill cyclone revision parts shipped air freight.
P.O. #23508 - Northern Mining - 2.3 and 3.0 mm flat deck screens shipped air freight - truck strike.

May 1, 1970 - Planning Meeting

Encountered many problems with pipelines plugging in the rod mill screen circuit. The rod mill screen was too small. We couldn't hold the desired rod mill feed tonnage. Flat deck screen cloths are being installed in place of the 1-foot wide DSM screen. They will be tested next week.

Low pressure cyclones are being reinstalled at the ball mills. Fine screens are being added to the ball mill circuit to try to improve grinding efficiency. Tests are continuing to eliminate the cobber magnetic separator and reduce water consumption.

May 2, 1970 - Drawing No. 28-4513 - Layout of 8" Wilfley pump and reclaimed tailings sump.

May 4, 1970 - Drawing No. 28-4527 - Concentrating flowsheet - 1970 revision.

May 6, 1970 - Drawing No. 28-4526 - P9D feed chute revisions.
Drawing No. 28-4515 - 8" Wilfley discharge piping layout for reclaimed tailing circuit.

May 7, 1970 - Drawing No. 28-4514 - Section A-A and details of sump Drawing No. 28-4513.
Drawing No. 28-4533 - Dry cobber collection box.
Work Order: 40237 - Install 8" Wilfley process water recirculating pump.
Work Order: 40239 - Remove rod mill vibrating screen.
P.O. #23928 - Indiana General - Experimental dry cobber.

May 8, 1970 - Drawing No. 28-4534 - Dry cobber collection box details.
P.O. #23921 - Langer Equipment - 3mm screen cloths.

May 8, 1970 - Planning Meeting
The past week was spent testing flat deck, stationary, rod mill screens. The screens blinded extensively and the rod mill pump kept plugging. The test was abandoned.

May 11, 1970 - Drawing No. 28-4536 - Dry cobber vane details.
Drawing No. 28-4549 - Details of rod mill straight screen pan and frame.
Work Order: 40240 - Fabricate curved rod mill recirculating screen.

May 12, 1970 - Drawing No. 28-4528 - Rod mill recirculating screen platform.
Drawing No. 28-4529 - Rod mill recirculating screen platform.

May 13, 1970 - Drawing No. 28-4530 - Rod mill recirculating screen retainer strip and block.

May 14, 1970 - Drawing No. 28-4532 - Dry cobber feed chute.
Drawing No. 28-4541 - Lowering of R9C.

May 15, 1970 - Planning Meeting

Flowsheet was operated without the rod mill screen in the circuit. Operational problems continued throughout the week. The rod mill pump and sump kept plugging.

A new curved stationary rod mill screen was installed. The screen is four feet wide.

Fine screen and low pressure cyclone tests in the ball mill circuit continue.

May 15, 1970 - Work Order: 40247 - Fabricate 7/8" ball charging tubs for R & D ball mills.

May 21, 1970 - Drawing No. 28-4531 - Dry cobber assembled.
Drawing No. 28-4552 - Rod mill straight screen plugs.
P.O. #24306 - Northern Mining - 3 curved screens - 4.75 and 6.0 mm - shipped air freight truck strike.

May 22, 1970 - Drawing No. 28-4544 - Lowering of R9C layout.

May 22, 1970 - Planning Meeting

The rod mill sump pump was replaced during the week. A smaller pump was installed to eliminate the plugging problem.

The rod mill pump speed was adjusted during the week to improve the pump operation. A variety of rod mill screen cloths were tested. We couldn't get the desired operating tonnage with any of the cloths tested. New screens are on order. They have larger openings. This should provide the screen capacity needed. Test results for the week were inconclusive.

The tailings thickener underflow pumps were tested with clear water. Work was started on the installation of a process water recycle system.

May 25, 1970 - Drawing No. 28-4523 - Rod mill recirculating screen.

May 26, 1970 - Drawing No. 28-4524 - Rod mill recirculating screen.
Drawing No. 28-4525 - Rod mill recirculating screen.

May 27, 1970 - Planning Meeting

The Pilot Plant was operated with the rod mill in open circuit during the past week. We are waiting for new rod mill screen cloths to be delivered. The lower portion of the mill circuit is being evaluated. The rougher and dewatering magnetic separators have low magnetic iron recoveries. The separators will be revised to increase the recovery. A smaller diameter ball is being charged in the ball mills. This should increase the mill circuit grinding capacity. The cyclone feed densities were too high. Therefore, the cyclones were not operating properly.

May 28, 1970 - Drawing No. 28-4551 - Straight screen feed box details.

May 29, 1970 - Drawing No. 28-4553 - Assembly view of rod mill straight screen.

June 1, 1970 - Drawing No. 28-4546 - Fabricate necessary for relocation of MS-1 at regrind mill discharge.

June 3, 1970 - Work Order: 40257 - Lower R9C conveyor.

June 5, 1970 - Planning Meeting
Testing continues.

Still having trouble with the rod mill screens. Slowly moving up testing to larger screen cloth openings. More screens have been ordered. Rougher magnetic separator and fine screen circuit testing also continues.

Tailings pumping tests are being conducted. Tailings were pumped to the delta. The pumps ran 12 hours during the past week without any operational problems.

June 5, 1970 - P.O. #25036 - Northern Mining - 5 rod mill screen cloths shipped air freight - truck strike.

June 9, 1970 - P.O. #24378 - Ramsey Engineering - Two conveyor scales - dry cobber monitoring.

June 10, 1970 - Drawing No. 28-4554 - Overall of R9C and dry cobber.
Work Order: 40261 - Fabricate two Vortex finders for ball mill cyclones.

June 11, 1970 - Drawing No. 28-4555 - Vortex finder.
P.O. #24888 - Krebs Engineers - Ball mill cyclone revision parts shipped air freight.

June 12, 1970 - Planning Meeting
The experimental dry cobber split in two during the second shift of the week. The Pilot Plant had to be shut down for the rest of the week. The drums separated around the circumference. A new dry cobbing magnetic separator will arrive at Reserve on June 13, 1970. It will be immediately installed in the Pilot Plant and testing will begin again on June 14, 1970. Instrumentation to determine exactly what is happening in the dry cobbing circuit is on order. The cyclone circuit is being revised to improve its efficiency. The overall circuit has not been producing the desired product grade. The ball mill circuit is overloaded. Revisions are continuing to try to eliminate these problems.

June 15, 1970 - Drawing No. 28-4557 - 10" Krebs cyclone layout.

June 16, 1970 - Drawing No. 28-4559 - 10" Krebs cyclone underflow catch box.
Drawing No. 28-4560 - 10" Krebs cyclone splitter.

June 17, 1970 - Drawing No. 28-4558 - 10" Krebs cyclone frames A & B.
Work Order: 40264 - Install 10" Krebs cyclones in place of 12" Dorr cyclones.

June 19, 1970 - Planning Meeting
The new dry cobber is running very well.

Tailings pumping tests in progress.

Production tonnage has been obtained with the rod mill screen this week. But, the rougher magnetic separator and the dewatering magnetic separator magnetic iron recoveries are not high enough. The separators are being revised to try to try to increase their efficiency.

June 25, 1970 - Work Order: 42068 - Install gross weight scale on R9C conveyor.

June 26, 1970 - Planning Meeting
The dry cobbing, tailings pumping and rod mill screen tests continue. The circuit is stabilizing. Instrumentation was installed in the dry cobbing circuit during the week. The magnetic separator recoveries are still poor. Revisions are continuing to try to eliminate the problem.

June 26, 1970 - Drawing No. 28-4563 - Sampler - dry cobber feed.

June 29, 1970 - Work Order: 40271 - Remove paddlewheel separator drum and install it in 4' Genier box.

June 30, 1970 - Work Order: 40275 - Fabricate scale calibration box for R9C magnetic scale.
Drawing No. 28-4564 - 10'-0 Rougher feed distributor.
Drawing No. 28-4565 - 10'-0 Rougher feed distributor location.

July 1, 1970 - Work Order: 40277 - Revise 10' rougher feed distributor.

July 2, 1970 - Planning Meeting
Testing of the tailings pumping, rod mill screening, and ball mill fine screen circuit continued. Magnetic iron recovery was still low. A decision was made to switch from rescreening primary fine screen underflow to rescreening primary fine screen overflow. The circuit will be installed over the 4th of July weekend.

July 6, 1970 - Drawing No. 28-4568 - Piping of DSM underflow to rougher elevation view.
P.O. #24835 - Allen Bradley - Experimental dry cobber drive.

July 7, 1970 - Drawing No. 28-4569 - Piping of DSM underflow to rougher plain view.
Drawing No. 28-4570 - 10' Rougher distributor box.

July 9, 1970 - Drawing No. 28-4572 - Calibration reel for conveyor R9C.

July 10, 1970 - Planning Meeting

Primary fine screen overflow was rescreened during the past week. Overall magnetic iron recovery was close to an acceptable value. But, the iron content of the concentrate was not high enough. The dewatering magnetic separator is still operating at a lower than desired magnetic iron recovery. We are designing a new separator to use in this location. The plant was down for two shifts when the rod mill sump pump failed in service.

July 13, 1970 - Drawing No. 28-4547 - Plan view - piping to MS-4 and MS-7.

July 14, 1970 - Drawing No. 28-4548 - Elevation view piping to MS-4 and MS-7.
Work Order: 40282 - Install two dewatering separators for ball mill fine screen circuit.

July 15, 1970 - John J. Franco, Hydraulic Engineer, Vicksburg, Mississippi, consultant, submitted a report recommending a series of launder flow tests using tailings now being obtained from pilot plant operation.

July 15, 1970 - Work Order #40285 - Fabricate fine screen feed splitter
Work Order #40283 - Fabricate dewatering separator concentrate drop box
Drawing #28-4573 - Revised concentrate drop box arrangement (MS-4 and MS-7) fabrication details
Drawing #28-4574 - General arrangement of MS-4 and MS-7 with piping layout
Drawing #28-4576 - Screen splitter

July 16, 1970 - Drawing #28-4577 - Screen splitter piping.

July 17, 1970 - Planning Meeting
Flowsheet testing continued. The magnetic iron recovery was close to an acceptable value. But, concentrate grade was lower than desired. A new dewatering separator is being installed in the circuit this week. The fine screen capacity is being doubled. And, we are going back to rescreening primary fine screen underflow.

July 20, 1970 - Work Order #40286 - Fabricate test tailings launder

July 21, 1970 - P. O. #26485 - Satterlee Company - 4 micrometer caliper heads - Tailings Launder Study

July 23, 1970 - Planning Meeting
Down one shift when a rougher pump discharge pipe split. Rescreening primary screen underflow. Lost a drive on the dewatering separator. Switched to spare dewatering separator to continue operation.

Rod mill screen is not operating efficiently. Planning to install two-stage screen next week to improve efficiency.

The siphonsizers are not producing the necessary product grade. We will revise one siphonsizer in an attempt to improve the efficiency.

Total tailings were pumped to the beach at 8% solids. Tests are in progress to determine the delta slope which will be produced with the new circuit.

July 24, 1970 - Drawing #28-4361 - 2' Rod mill recirculating screen
Drawing #28-4360 - Layout details - Drawing #4361

July 27, 1970 - Drawing #28-4579 - Rod mill screen overflow trough

July 28, 1970 - P.O. #26946 - Zalk-Josephs - Fabricate one rod mill screen assembly
Work Order #40288 - Install two-stage rod mill screen

July 31, 1970 - Planning Meeting
Two-stage rod mill screen being installed today.

Tailings delta slope tests are being run with various percent solid streams. The data obtained will be used to estimate what effect percent solids and particle size will have on the slope of the main tailings delta.

One pilot plant flowsheet is not producing an acceptable grade product. The lower portion of the test circuit is being revised in an attempt to improve the product grade.

August 7, 1970 - Planning Meeting
Testing continues. The two-stage rod mill screen needs to be revised. The screen plugged several times a day throughout the week. Slurry from the screen got into the rod mill drive gears. The mill gears will have to be completely stripped and cleaned over the weekend.

The rod mill sump pump failed early in the week. One shift was required to repair the pump.

Siphonsizer revisions continue. The product grade is starting to improve. Several more revisions will be required to obtain the desired product grade.

The top size of balls being charged to the ball mills is going to be lowered to 1¼-inch diameter balls. This will improve the mill efficiency.

August 7, 1970 - P.O. #27722 - Armco Steel Corporation - 1¼-inch diameter grinding balls for experimental circuit.

RESERVE MINING COMPANY

MEMORANDUM

TO E. M. Furness DATE August 9, 1970

FROM K. M. Haley

SUBJECT Project Scheduling Through October, 1970

Attached is a tentative schedule of necessary research testing in the pilot plant through October, 1970. By that time, all related pilot plant work required for more definitive evaluation of various proposals to modify the tailings discharge system should be completed.

This amount of time is necessary to assure at least four test weeks after one or two weeks of troubleshooting and preliminary testing for each circuit. The fine screen and flotation circuits cannot be scheduled concurrently due to the large number of samples and lab analyses required. In all cases, four weeks for data analysis and report writing were allowed after the last test week.

Dry Cobber

Testing continues on the dry cobber to insure that taconite from all sections of the mine have been encountered, and the complete variation in the cobbing characteristics of the taconite ore is established. A control circuit which makes adjustments for changes in the incoming taconite characteristics must be developed. Magnetic drums from different manufacturers will be evaluated and compared.

Rod Mill Screen

A screen has been installed and tested in closed circuit with the rod mill when dry cobbing is used ahead of the rod mill. The purpose is to perform more grinding in the rod mill and, thereby, gain better control of the tailings size distribution.

Work to date has shown little, if any, effect on the rod mill work index or reduction ratio due to close-circuiting the rod mill with a single-stage screen.

To improve the efficiency of the screen in future testing, the first screen overflow will be resecreened on a slightly finer screen. Overflow from this second stage of screening will be returned to the rod mill for further grinding. A good portion of the test time will be used to determine how fine a rod mill circuit product can be produced using the closed-circuit screen. Also, operating procedures have to be developed so that the screens can be used with minimum operating problems on a production scale.

Attachment E

Rod Mill Discharge Directly to Rougher Magnetic Separator

A newly designed high intensity permanent magnetic separator is being tested in an effort to improve the separation of tailings from concentrate at the largest particle size possible. Additional pilot plant testing is required to determine the capacity and operating characteristics of this equipment with this type of feed.

Fine Screens

The classification has been the weakest portion of all taconite mineral beneficiation circuits. In an effort to improve classification and obtain better control of the particle size distribution of both concentrate and tailings, test work is being done performing the primary classification in two steps. Conventional clone classification is the first step to give a coarse size separation. The fine fraction is then screened with fine screens as the second step. The coarse product from both clone classifiers and screens is returned for further ball mill grinding.

Continued progress is being made in this fine screen circuit. One important question to be answered as yet is whether or not we have enough grinding capacity in our primary ball mills. With approximately four more weeks of testing, we should be able to answer this question. In addition, operating procedures must be finalized to insure smooth installation and operation in the Concentrator.

Siphonsizer Testing

Due to the changes in primary classification, this equipment is now being fed a more uniform distribution of particle size material at much lower percent solids. A series of tests are necessary to develop the optimum operating practice for this changed condition.

Flotation

Test work has been conducted using flotation equipment as a final piece of classification equipment. The purpose is to improve the classification so that our process only grinds the particles to the extremely fine size that is necessary for liberation of magnetite. Thus, high grade concentrate would be produced without excessive overgrinding of the tailings particles.

Three weeks of preliminary testing are necessary to (1) test and calibrate a pulp level control on the flotation cells and (2) test and calibrate the new reagent pumps. Four test weeks have been scheduled to minimize the effect of varying taconite concentrating and flotation characteristics.

Closed-Circuit Water

The tailings with a much smaller top size may be conveyed through launders at a higher percent solids than present practice. It is anticipated that the amount of tailings that will be retained as a tailings beach is directly proportional to the percent solids of the tailings discharge. Therefore, if we can reduce the amount of water with the tailings, we will increase the amount of tailings that remain as a beach and decrease the amount discharged off of the edge of the beach into the lake.

In order to reduce the amount of water used in our process, tailings water from the hydroseparator, the finisher magnetic separators, and the siphonsizers will be used as wash water for the rougher magnetic separators and makeup water for the rod mill and rougher sumps. Testing will be required to insure that the recycled water does not have an adverse effect on the process.

Tailings Pumping

Testing in this area continues to (1) study the tailings beach developed when tailings are discharged at 8% solids, (2) determine the feasibility of discharging tailings at a point 150 feet below the surface of Lake Superior, creating an underwater sand reef, and (3) study the fluid flow characteristics of tailings. Testing and observation of the tailings beach are greatly dependent upon weather conditions. Therefore, a considerable amount of time must be allotted for this test.

Flocculent Testing

Laboratory testing indicated that at least six commercial flocculents could be effectively used for tailings treatment in our application. Three have been tested on a pilot plant scale, and three more remain to be tested. Approximately a week is required for each. These tests are extremely important since flocculent costs will play an important part in determining the economic feasibility of any tailings treatment system. It may be feasible to consider flocculating total tailings in a single stage of settling. This idea will be tested.

K M Haley

K. M. Haley
Vice President and Manager
R & D

KMH:sb
Enc.

PROJECT SCHEDULING THROUGH OCTOBER 1970

Project	Week of: Aug. 3	Aug. 10	Aug. 17	Aug. 24*	Aug. 31	Sept. 7	Sept. 14	Sept. 21	Sept. 28	Oct. 5	Oct. 12	Oct. 19	Oct. 26
1. Dry Cobbing	T	T	T	-	R	T	T	T	D.A.	D.A.	D.A.	D.A.	-
2. Rod Mill Screen	T	T	T	-	T	D.A.	D.A.	D.A.	D.A.	-	-	-	-
3. Dry Cobbing Control	-	-	-	-	-	-	-	-	T	T	T	(Pending Equip. Arrival)	
4. Fine Screens	T	T	T	-	T	D.A	D.A.	D.A.	D.A.	-	-	-	-
5. Rod Mill Discharge to Rougher	T	D.A.	D.A.	D.A.	D.A.	-	-	-	-	-	-	-	-
6. Siphonsizer Tests	T	T	D.A.	D.A.	D.A.	D.A.	-	-	-	-	-	-	-
7. Flotation	-	R	R	-	R	T	T	T	T	D.A.	D.A.	D.A.	D.A.
8. Closed-Circuit Water	R	T	T	-	T	T	T	D.A.	D.A.	D.A.	D.A.	-	-
9. Tailings Pumping	T	T	T	-	T	T	T	T	D.A.	D.A.	D.A.	D.A.	-
10. Flocculant Testing	-	-	T	-	T	T	T	D.A.	D.A.	D.A.	D.A.	-	-

R - Run Only
T - Test
D.A. - Data Analysis and Report
* - Down Week - East Concentrator is shut down for maintenance

RESERVE MINING COMPANY

ENGINEERING TASK FORCE
PROGRESS REPORT

REVISED
AUG 1 0 1970

August 10, 1970

Colored inserts in this book represent new or additional information--as of August 10, 1970. These pages appear immediately following the white pages they supplement. See Proposals #13, #15, #17, #18, #19.

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April 9, 1970

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2 Disposal of Tailings Near Taconite Mine
3 Disposal of Fine Tailings Only in the Lax Lake Area
4 Fine Tailings Disposal by Deep Pipe Into Lake
5 Tailings Disposal Under a Protective Curtain
6 Coarse Tailings Rail-Hauled to Lax Lake Area All Year
7 Coarse Tailings Rail-Hauled to Lax Lake Area Summer Months Only
8 Coarse Tailings Conveyed to Lax Lake Area All Year
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10 Coarse Tailings Rail-Hauled to Mile Post 32 All Year
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12 Fine Tailings Discharged Through An Underwater Diffuser
13 Lake Shore Tailings Pond
14 Thickened Coarse Tailings Delta
15 Underwater Sand Reef Beneficial to Bottom Fauna and Fish
16 Small Boat Harbor and Swimming Area
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18 Screening Ore Ahead of the Rod Mill
19 By-Product Use of Tailings

INTRODUCTION

Last year Reserve Mining Company announced formation of an engineering task force to investigate and study any proposed possible method of altering or modifying its discharge of tailings (waste sand) to Lake Superior. Reserve does not believe its discharge is causing--in the language of the statutes--any material damage to Lake Superior or endangering the health or welfare of people of Minnesota or any other state. These studies were undertaken not because the lake was being harmed by Reserve's present tailings discharge system, but to determine if there were some other practicable method which would relieve the concern some people have about the company's use of the lake.

This task force--composed of Reserve engineers and scientists and specialists from nationally-known consulting engineering firms--has been expanded from time to time to include more engineers and new talents which were required as new ideas were conceived. Today, the consulting firms involved in one or more preliminary engineering investigation related to disposal of Reserve's tailings and their storage, handling or use are:

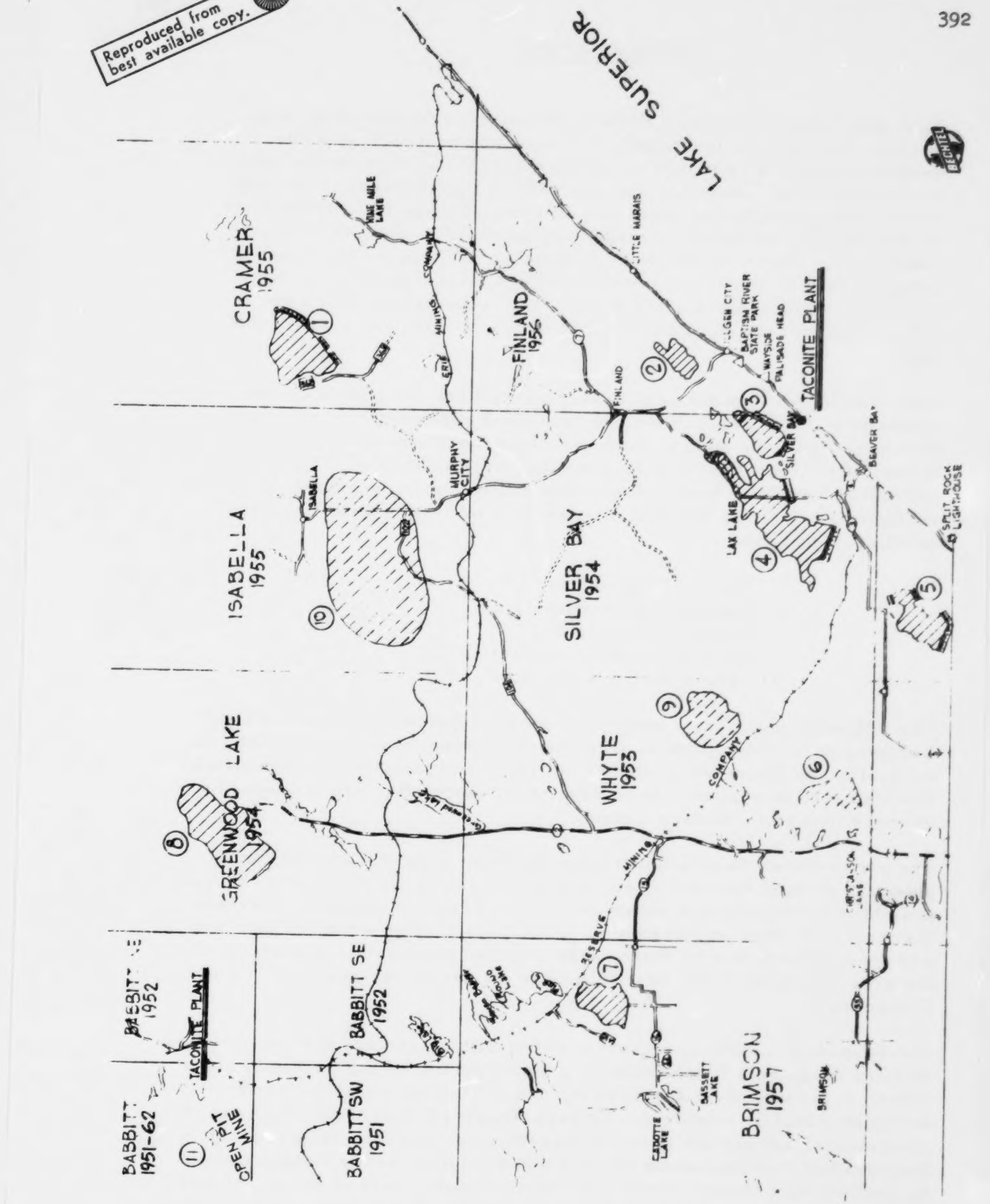
Bechtel Corporation
Engineering-Science, Inc.
Arthur D. Little, Inc.
Parsons-Jurden Corporation
Trygve Hoff & Associates

The following pages are a progress report prepared by Reserve Mining Company on investigations of all proposals; none have been omitted. In several cases where the study has not yet been completed, an estimated completion date is given. In no case is the completion date believed to be more than 60 to 90 days distant.

The entire Silver Bay-Babbitt region has been carefully studied for potential on-land disposal sites. Eleven locations which appeared to have possibilities initially are shown on the next page. Investigation revealed that only four sites appeared to have any possibilities whatever and they are considered in one or more of the attached proposals. In each case, the area described is the best suited for the particular proposal in which it appears.

The proposals involving thickening and clarifying require the use of flocculents or coagulants which make up a major portion of the operating costs cited. A settling agent approved for use in treating water for human consumption would be employed. To keep Reserve's finished product quality competitive, amines for flotation classification would be required. Only biodegradable amines would be used and all water used in flotation would be confined to a closed circuit. No portion of the costs of amine "closed water" classification systems is included in any of the following estimates.

Reproduced from best available copy.


LAKE SUPERIOR
CRAMER 1955
①
NINE MILE LAKE
LITTLE MARAIS
FINLAND 1956
②
ILLGEN CITY
BAPTISM RIVER STATE PARK
WAYSIDE
PALISADE HEAD
TACONITE PLANT
FINLAND
ERIE MINING COMPANY
③
SILVER BAY
BEAVER BAY
SPLIT ROCK LIGHTHOUSE
ISABELLA 1955
ISABELLA
MURPHY CITY
⑩
SILVER BAY 1954
LAX LAKE
④
⑤
GREENWOOD LAKE 1954
⑧
WHYTE 1953
⑨
⑥
RESERVE MINING COMPANY
⑦
CHRISTIANSON LAKE
BABBITT NE 1952
TACONITE PLANT
BABBITT SE 1952
BABBITT 1951-62
⑪ OPEN PIT MINE
BABBITT SW 1951
CADOTTE LAKE
BASSETT LAKE
BRIMSON 1957
BRIMSON

PROPOSAL #1

"TOTAL TAILINGS DISPOSAL IN LAX LAKE AREA"

ENGINEERING STUDY BY:

Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION:

This is a reasonably complete study of the proposal originally examined--but not recommended--by the U. S. Bureau of Mines that all Reserve tailings be pumped to a tailings basin in the area of Lax Lake above the high ridge behind Silver Bay.

Coarse tailings would be separated from fine tailings by hydroseparation. All tailings would be ground to -10 mesh and thickened. The thickener overflow would be returned to the concentrator as recycled water. Underflow from the thickeners, containing all of the tailings, would be pumped to the Lax Lake area over an 800-foot elevation from the level of the present delta and would be impounded behind dams. Water from the tailings pond would be returned to the concentrating plant as process water.

This study assumes that electric power can be purchased from Minnesota Power and Light Company, thereby eliminating the construction by Reserve of a power generating facility costing many millions of dollars. Construction of a power line from Duluth to Silver Bay to deliver 95,000 kw would be necessary, however.

PRELIMINARY EVALUATION:

The estimated partial capital cost of this proposal is $195,183,000 and does not include such items as land acquisition; preparation of the basin area; financing and interest; distribution pumping equipment; transmitting power, lights and communications at dams; abandonment of Lax Lake road (County Highway #4); permanent dam access roads; plant depreciation; inflation before construction is started; and computer rental.

Proposal #1

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$12,280,000
Depreciation	6,294,000
Interest	8,710,000
Total estimated average annual cost	$27,284,000

The proposal does not appear to be sound from a conservation standpoint. To the contrary, serious conservation problems would be encountered. The area suggested is prime hunting, fishing, recreation and resort country, with both seasonal and year-around homes. All would be covered by the tailings basin; Lax Lake itself would cease to exist. Dust from blowing tailings could be expected to affect the region.

Since the watershed drainage would exceed Reserve's total needs, excess water (containing fine tailings) from the basin would go into the Beaver River and enter Lake Superior--in spite of a series of dams so high and long that they would be among the largest in the nation.

Also, the fine tailings would enter the lake so "diluted" in the river water, no heavy density current would form to carry them to the great depths of the lake. The fine tailings would be in surface waters until they settled out naturally.

No "problems" would be solved. Further, the huge tailings basin poised high above the residences of the Beaver Bay region on the North Shore could be a safety hazard.

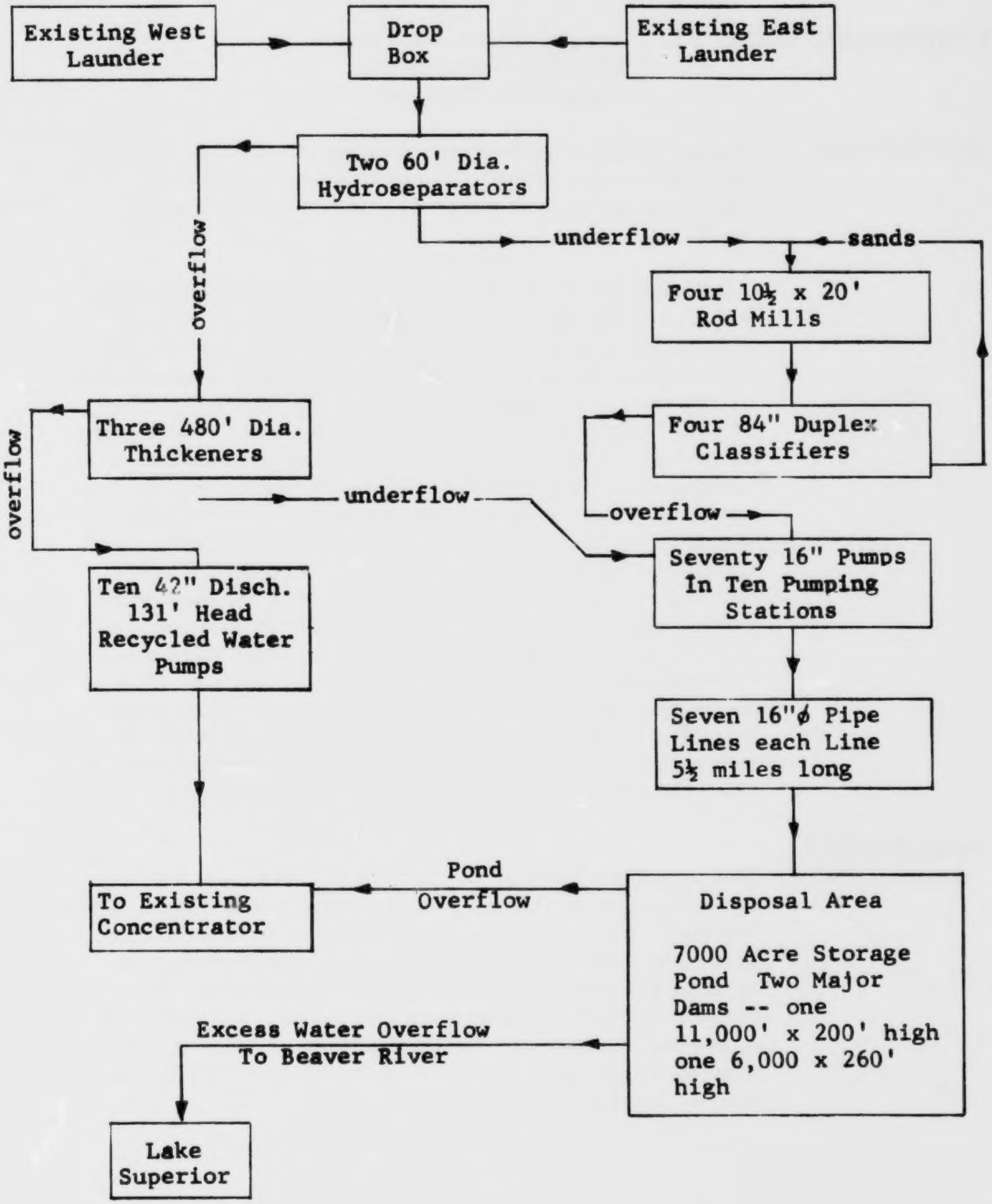
PROGRESS: Preliminary engineering study 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #1

"TOTAL TAILINGS DISPOSAL IN LAX LAKE AREA"


Existing West Launder
Drop Box
Existing East Launder
Two 60' Dia. Hydroseparators
overflow
underflow
sands
Four 10½ x 20' Rod Mills
Four 84" Duplex Classifiers
Three 480' Dia. Thickeners
overflow
underflow
overflow
Ten 42" Disch. 131' Head Recycled Water Pumps
Seventy 16" Pumps In Ten Pumping Stations
Seven 16"ø Pipe Lines each Line 5½ miles long
Pond Overflow
To Existing Concentrator
Disposal Area
7000 Acre Storage Pond Two Major Dams -- one 11,000' x 200' high one 6,000 x 260' high
Excess Water Overflow To Beaver River
Lake Superior

PROPOSAL #2

"DISPOSAL OF TAILINGS NEAR TACONITE MINE"

ENGINEERING STUDY BY: Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: This proposal incorporates hauling all tailings by railroad to the Babbitt, Minnesota area, stacking the material on land south of the Reserve taconite mine.

Total tailings would be fed into drag classifiers which would remove the coarsest tailings to be carried by belt conveyors to a junction point. The finer tailings would be in the overflow from the classifiers and would be fed into four huge thickeners. Thickener overflow of relatively clear water would be returned to the plant as process water. Thickener underflow would be pumped to a filter building where the remaining tailings would be filtered out and discharged onto conveyors which bring them to the above mentioned junction point. Combined tailings would be conveyed up the hill on a belt conveying system to loading bins in the rail yard. At this point the tailings would contain 20% moisture. The material would be loaded into railroad cars and transported to an area south of the Babbitt pit. The railroad cars would be dumped by car dump facilities installed at Babbitt and the damp tailings stacked 50 feet high over a large area. For winter operations, a thaw shed would be built to thaw out frozen cars.

PRELIMINARY EVALUATION: The estimated partial capital cost of $74,132,000 does not include such items as land acquisition; financing and interest; plant depreciation; inflation to date of construction; the necessary addition to the distribution system at Babbitt after five years of stacking; computer rental; repair, maintenance and fueling facilities for rail operating equipment; dust collectors at loading and unloading sites; gas main to heating boiler; nor air pollution control equipment.

Proposal #2

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 6,210,000
Depreciation	2,972,000
Interest	3,308,000
Total estimated average annual cost	$12,490,000

Reserve engineers believe the thaw shed equipment appears to be inadequate for winter operation and that it might be necessary to use electrically heated, insulated railroad cars, in addition to that thaw shed for emergency use only. However, such cars are new and untried and would require pilot operations before being considered.

Also, the conveyor system planned would suffice for only five years' operations. Additional and more flexible conveyor systems would have to be designed and evaluated before this proposal could be considered.

Engineering and operating difficulties make this proposal highly questionable from a technical feasibility standpoint.

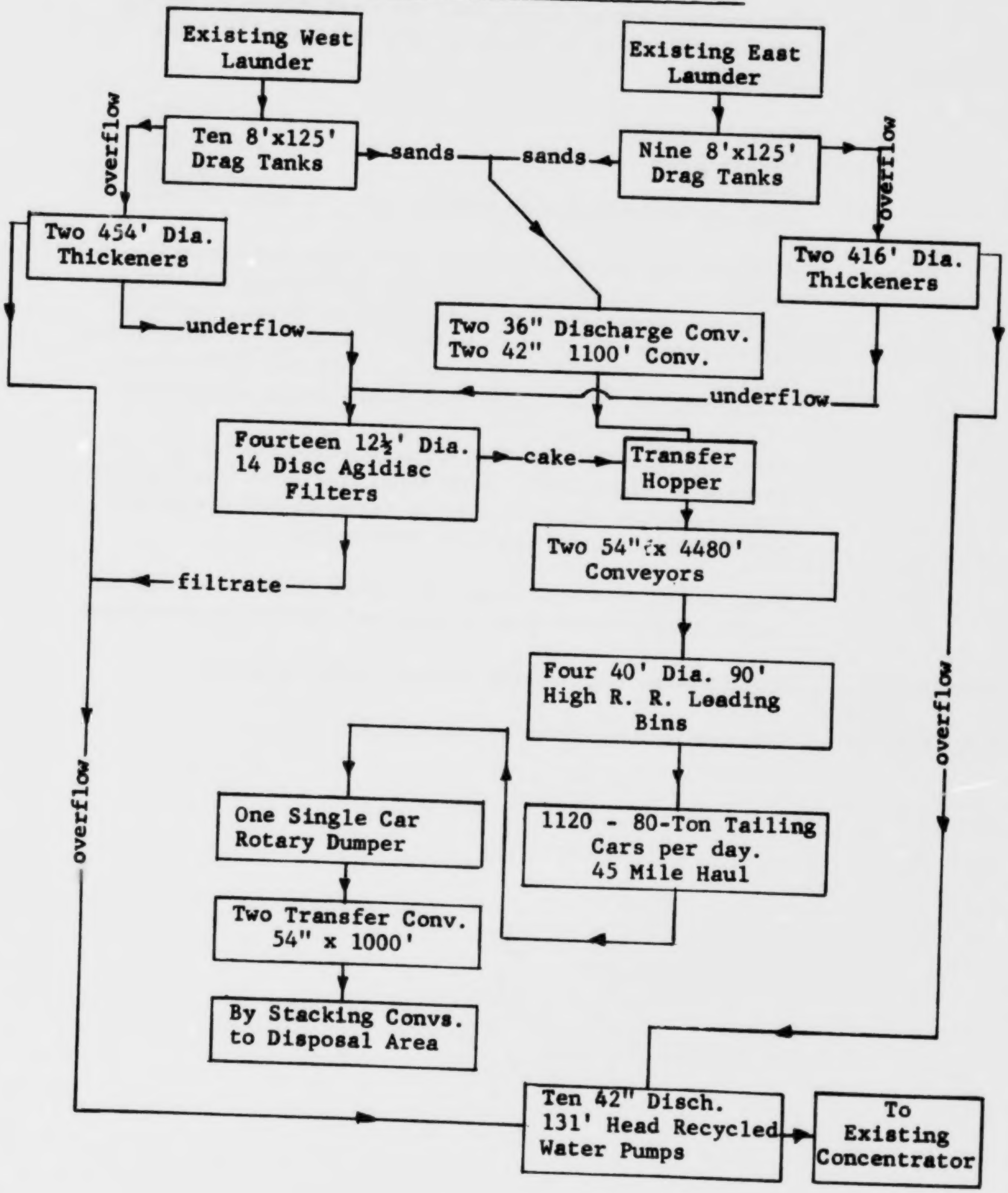
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #2

"OVERLAND DISPOSAL OF TAILINGS BY RAILROAD"


Existing West Launder
Existing East Launder
overflow
Ten 8'x125' Drag Tanks
sands
sands
Nine 8'x125' Drag Tanks
overflow
Two 454' Dia. Thickeners
Two 416' Dia. Thickeners
underflow
Two 36" Discharge Conv. Two 42" 1100' Conv.
underflow
Fourteen 12½' Dia. 14 Disc Agidisc Filters
cake
Transfer Hopper
Two 54" x 4480' Conveyors
filtrate
Four 40' Dia. 90' High R. R. Leading Bins
overflow
overflow
One Single Car Rotary Dumper
1120 - 80-Ton Tailing Cars per day. 45 Mile Haul
Two Transfer Conv. 54" x 1000'
By Stacking Convs. to Disposal Area
Ten 42" Disch. 131' Head Recycled Water Pumps
To Existing Concentrator

PROPOSAL #3

"DISPOSAL OF FINE TAILINGS ONLY IN THE LAX LAKE AREA"

ENGINEERING STUDY BY: Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: This proposal would separate total tailings into a fine (-500 mesh) fraction and a coarse (+500 mesh) fraction. The fine fraction would be pumped to a tailings basin in the Lax Lake area. Coarse tailings would be deposited across a delta and into Lake Superior as Reserve now disposes of its total tailings.

Total tailings would flow to drop box separators where the coarse tailings would settle out and be pumped to a mixing station. Overflow from the drop box separators would feed into four thickeners. Thickener underflow would be +500 mesh material. It would be pumped to a mixing station where sufficient water would be added for it to flow down launders and discharge across the delta in a system similar to the present one employed by Reserve. These tailings would form a heavy density current and be carried to the bottom.

The thickener overflow would go to six clarifiers. Overflow from the clarifiers would be returned to the plant as process water. Underflow (-500 mesh) would be pumped to the Lax Lake area and retained behind rock dams in a sufficiently large tailings disposal area to allow overflow of reasonably clear water to the Beaver River. The clear water overflowed to the Beaver River probably would be less than 25 JTU.

PRELIMINARY
EVALUATION: Partial estimated cost of $62,933,000 does not include such items as land acquisition; clearing of basin area; financing and interest charges; distribution pumping; power, lights and communications equipment at dams; permanent dam access roads; plant depreciation; inflation; and computer rental.

Proposal #3

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 5,589,000
Depreciation	1,893,000
Interest	2,808,000
Total estimated average annual cost	$10,290,000

The thickeners and clarifiers were sized on rather sketchy theoretical data. The pilot plant was operated during the months of January and February to develop actual data on the size equipment needed for these separations and classifications. This data indicates that the thickeners planned were slightly oversize and the clarifiers were slightly undersize. The overall effect should be essentially no change in the estimated capital and operating costs.

Many problems would result from this proposal because of the large tailings basin located in a resort, hunting, fishing and year-around residence region. There would be dust blowing from the tailings pond. The overflow from the tailings basin would be continuous. Fine tailings would be carried into the Beaver River and to Lake Superior. The tailings entering Lake Superior via the Beaver River would be too diluted to form a heavy density current. Therefore, they would settle to the lake bottom much slower than those entering the lake by our present practice. The tailings delta would have the same appearance that it does now.

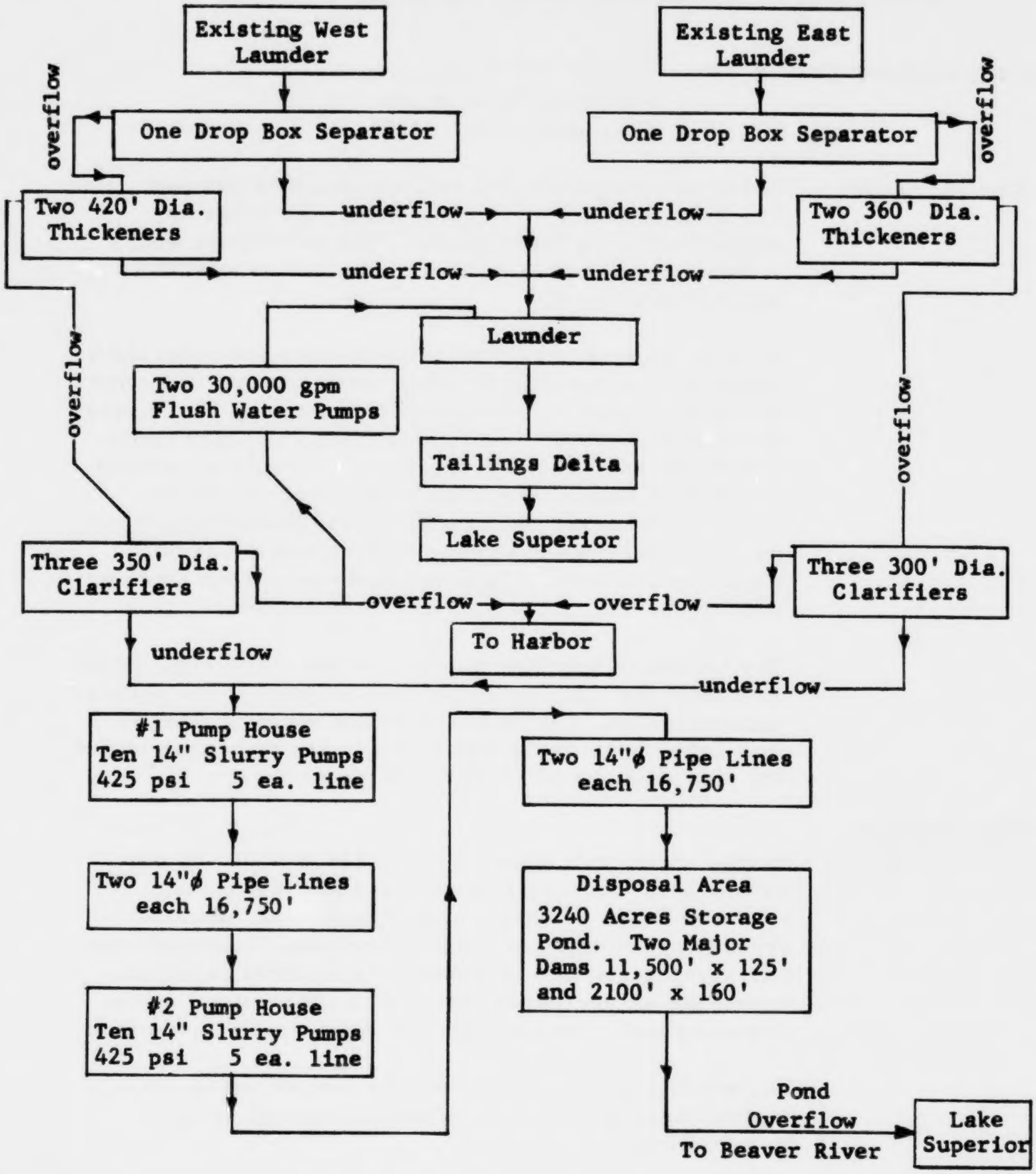
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #3

"DISPOSAL OF FINE TAILINGS ONLY IN THE LAX LAKE AREA"


Existing West Launder
Existing East Launder
overflow
One Drop Box Separator
One Drop Box Separator
overflow
Two 420' Dia. Thickeners
underflow
underflow
Two 360' Dia. Thickeners
underflow
underflow
overflow
Launder
Two 30,000 gpm Flush Water Pumps
overflow
Tailings Delta
Lake Superior
Three 350' Dia. Clarifiers
overflow
overflow
Three 300' Dia. Clarifiers
underflow
To Harbor
underflow
#1 Pump House Ten 14" Slurry Pumps 425 psi 5 ea. line
Two 14"ϕ Pipe Lines each 16,750'
Two 14"ϕ Pipe Lines each 16,750'
Disposal Area 3240 Acres Storage Pond. Two Major Dams 11,500' x 125' and 2100' x 160'
#2 Pump House Ten 14" Slurry Pumps 425 psi 5 ea. line
Pond Overflow To Beaver River
Lake Superior

PROPOSAL #4

"FINE TAILINGS DISPOSAL BY DEEP PIPE INTO LAKE"

ENGINEERING STUDY BY: Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: Under this proposal, fine tailings would be pumped into Lake Superior via a submerged pipe below any surface-affecting thermocline. Coarse tailings would be deposited across a delta into the lake as total tailings are at present.

Briefly, total tailings would flow to drop box separators where the coarse tailings would settle out and be pumped to a mixing station. Overflow from the drop box separators would feed into four thickeners. Thickener underflow would be +500 mesh material. It would be pumped to a mixing station where sufficient water would be added for it to flow down launders and discharge across the delta in a system similar to the present one employed by Reserve. These tailings would form a heavy density current and be carried to the bottom.

The thickener overflow would go to six clarifiers. Overflow from the clarifiers would be returned to the plant as process water. Clarifier underflow would be pumped into Lake Superior through a pipe. The discharge end of the pipe would be 150 feet below the surface.

PRELIMINARY EVALUATION: Partial estimated capital costs of $14,854,000 do not include such items as financing and interest costs; submerged pipe extension and replacement; plant depreciation; inflation to construction date; computer rental; computerization of controls; additional capacity to provide for increased steam load for heating; sampling and standby equipment; and pump repair equipment.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 4,280,000
Depreciation	570,000
Interest	663,000
Total estimated average annual cost	$ 5,513,000

Proposal #4

The thickeners and clarifiers were sized on rather sketchy theoretical data. The pilot plant was operated during the months of January and February to develop actual data on the size equipment needed for these separations and classifications. This data indicates that the thickeners planned were slightly oversize and the clarifiers were slightly undersize. The overall effect should be essentially no change in the estimated capital and operating costs.

The proposal would place the fine fraction of the tailings below any surface-affecting thermocline, in this way virtually eliminating the small amount of tailings that may, under certain conditions, be found in the surface water.

The system answers some, but not all of the criticisms that have been made about the existing method of tailings disposal.

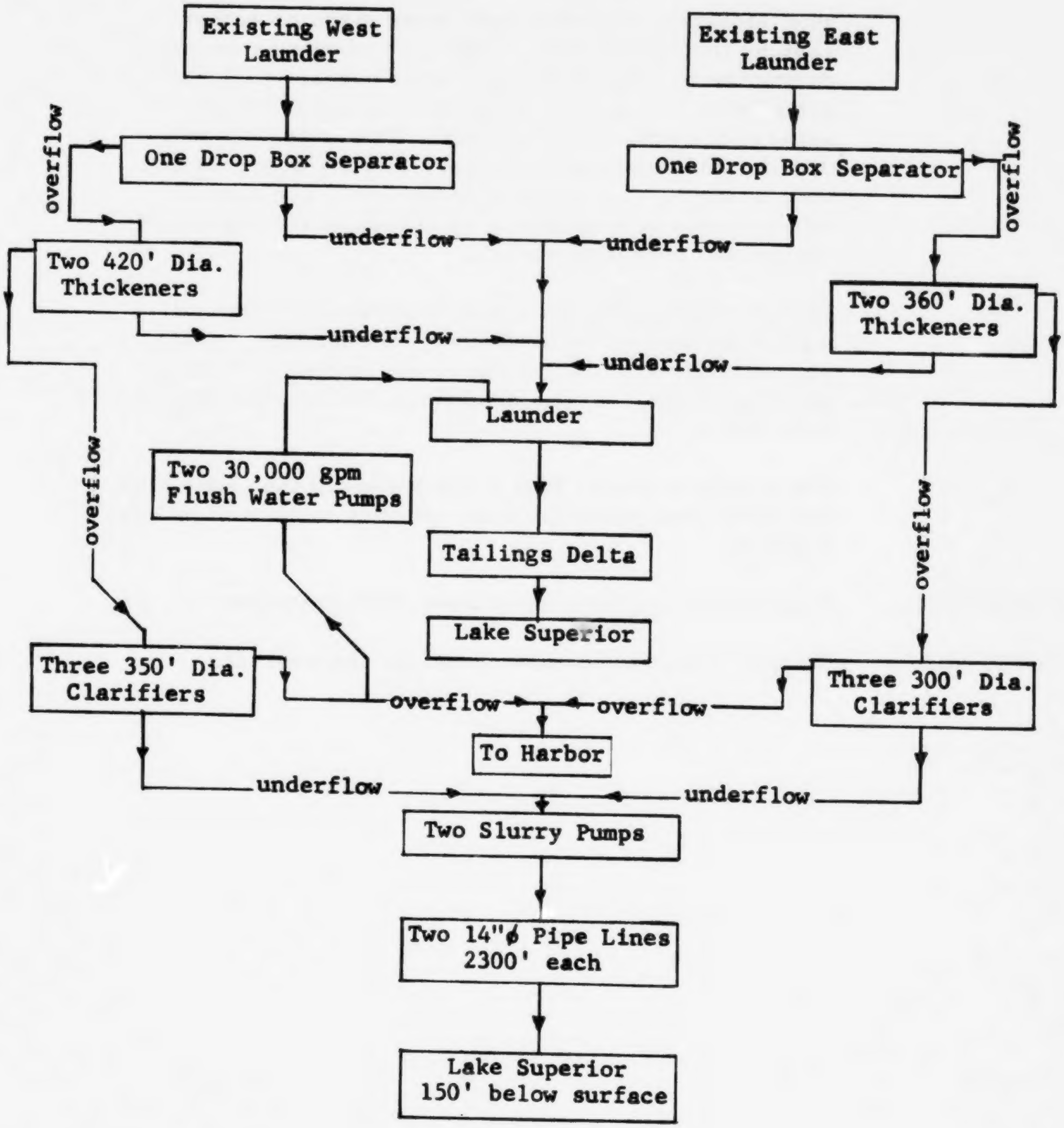
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Further investigation abandoned for the present.

FLOW SHEET

PROPOSAL #4

"FINE TAILINGS DISPOSAL BY DEEP PIPE INTO LAKE"


Existing West Launder
Existing East Launder
One Drop Box Separator
One Drop Box Separator
overflow
overflow
underflow
underflow
Two 420' Dia. Thickeners
Two 360' Dia. Thickeners
underflow
underflow
Launder
Two 30,000 gpm Flush Water Pumps
overflow
overflow
Tailings Delta
Lake Superior
Three 350' Dia. Clarifiers
Three 300' Dia. Clarifiers
overflow
overflow
To Harbor
underflow
underflow
Two Slurry Pumps
Two 14"ø Pipe Lines 2300' each
Lake Superior 150' below surface

PROPOSAL #5

"TAILINGS DISPOSAL UNDER A PROTECTIVE CURTAIN"

ENGINEERING STUDY BY: Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: Under this proposal the tailings flow from the Reserve delta would pass under a 100-foot deep vertical curtain to enter the lake below any thermoclines. Theoretically, this would eliminate or materially reduce the minor amount of tailings which, under certain conditions, may be found in surface waters.

From mid-October to mid-June, diversion dikes would control development and shape of the deltas of the two tailings launders (see accompanying sketch), forcing the ends of the divided beach to grow faster than the centers. As these protruding edges build up to the water surface level, they would be protected by rock dikes or clusters of pilings. This would produce a double-concaved delta edge, open toward the lake.

The diversion dikes would be removed or openings would be made in them from mid-June to mid-October. The curtain would be placed across the opening of each concave-shaped tailings delta. Edge diversion dikes might be necessary to direct the tailings stream to approximately the center of each delta concave. Heavy density currents would be contained by the delta shape and forced to flow under the curtain below the depth of the surface-affecting thermoclines.

PRELIMINARY EVALUATION: The partial estimated capital cost of $3,854,000 does not include such items as financing and interest cost; plant depreciation; and inflation to the construction date.

The average annual costs over the next ten years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 1,616,000
Depreciation	406,000
Interest	190,000
Total estimated average annual cost	$ 2,212,000

Proposal #5

This proposal would, in theory, prevent tailings from Reserve's discharge being found in surface waters.

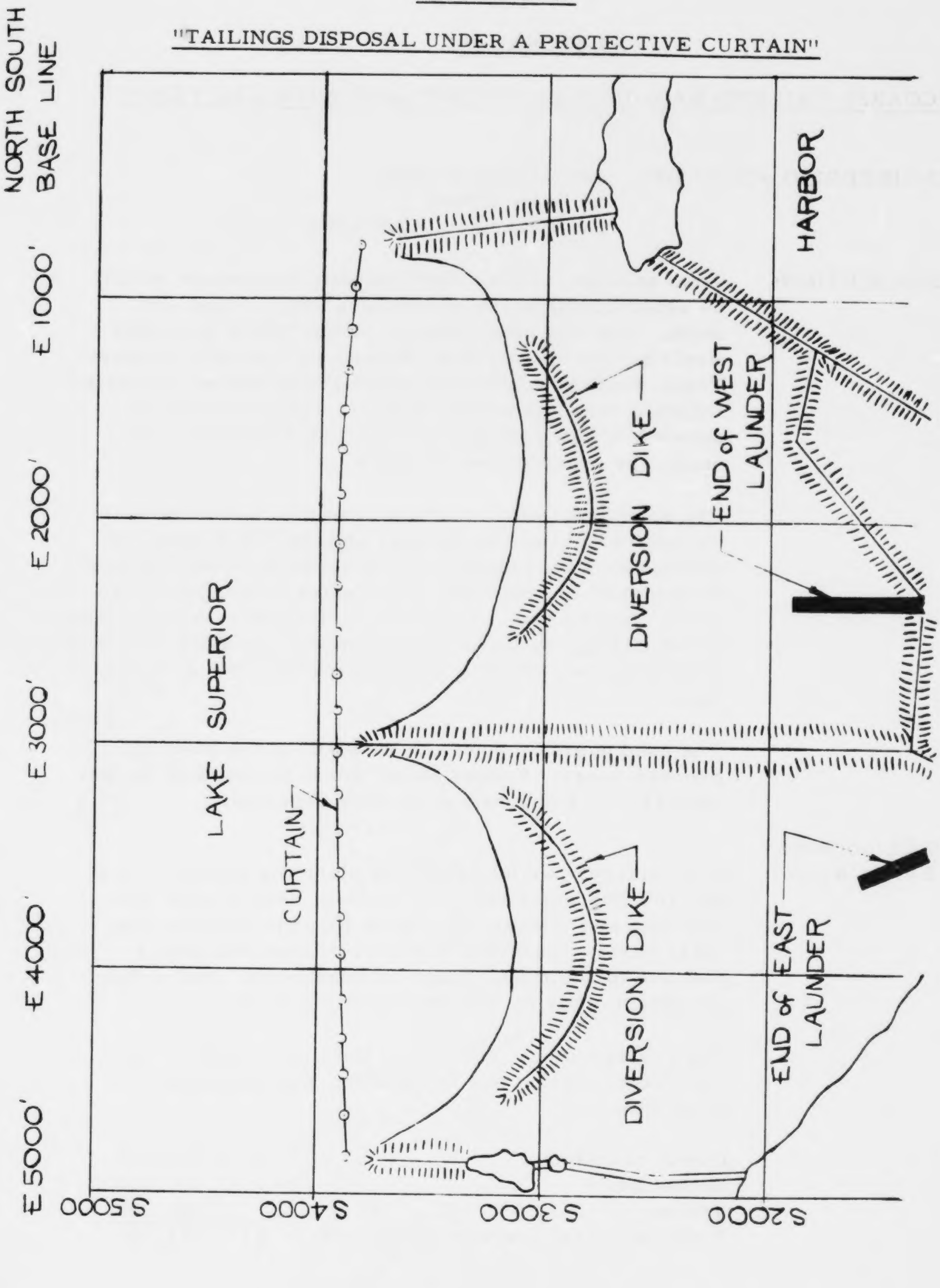
A delta of this shape would also hold to a minimum the movement of tailings by wave action which now stirs the beach and may cause some fine tailings to be temporarily suspended in the surface water.

This proposal has the lowest capital and operating cost of the group. However, the curtain principle is entirely new and untried. The proposal would fail if the curtain could not be maintained in position against wave and current action. Reserve engineers believe other proposals present a higher probability of success.

PROGRESS:	Preliminary engineering study 100% complete.
TIMETABLE:	No further engineering work planned; proposal abandoned.

PROPOSAL #5

"TAILINGS DISPOSAL UNDER A PROTECTIVE CURTAIN"


NORTH SOUTH BASE LINE
E 1000'
E 2000'
E 3000'
E 4000'
E 5000'
S 5000
S 4000
S 3000
S 2000
HARBOR
END of WEST LAUNDER
DIVERSION DIKE
LAKE SUPERIOR
CURTAIN
DIVERSION DIKE
DIVERSION DIKE
END of EAST LAUNDER

PROPOSAL #6

"COARSE TAILINGS RAIL-HAULED TO LAX LAKE AREA ALL YEAR"

ENGINEERING STUDY BY:

Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION:

Total tailings from cobber magnetic separators would be separated by spiral classifiers into +35 and -35 mesh. The +35 mesh product (about 50% of the total) would be belt-conveyed to storage bins at 18% moisture. These would be loaded into electrically heated, insulated railroad cars and hauled 5½ miles and then would be carried by belt conveyors to the Lax Lake area and spread by conventional stackers.

The spiral classifier overflow would be combined with the balance of the fine tailings and fed into thickeners through existing launders. The thickener overflow would be returned as relatively clear water to the plant for use in the process. Thickener underflow with the balance of the tailings would be pumped to the Lax Lake area and impounded behind dams constructed from the coarse tailings.

The pond overflow would be returned to the plant as process water. Excess water would be clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION:

Preliminary, partial estimates place the capital cost at $44,100,000 which does not include: land acquisition; financing and interest; inflation prior to construction; spare parts; operating supplies; higher unit power cost due to additional power requirements; and mobile equipment other than railroad rolling stock.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 3,750,000
Depreciation	2,105,000
Interest	1,968,000
Total estimated average annual cost	$ 7,823,000

Proposal #6

The hauling of tailings containing 18% moisture in winter presents real problems. Bottom-dump rail cars would dribble, causing icing on the railroad. The electrically heated insulated rail car is a new, untried concept and extensive pilot testing would be necessary before the system could be considered further. Also, the conveyor system from the classifiers must be re-designed before it will operate satisfactorily.

Serious conservation problems would result from adoption of a tailings basin in the Lax Lake area. This prime resort, hunting and fishing region and year-around residential area would be destroyed for these purposes. Dust from blowing tailings would be a problem. Very fine tailings would flow to Lake Superior from time to time because of the necessity for diversion and/or overflow via the Beaver River and Palisade Creek. Also, the huge tailings basin poised high above the Beaver Bay-North Shore area could be a safety hazard.

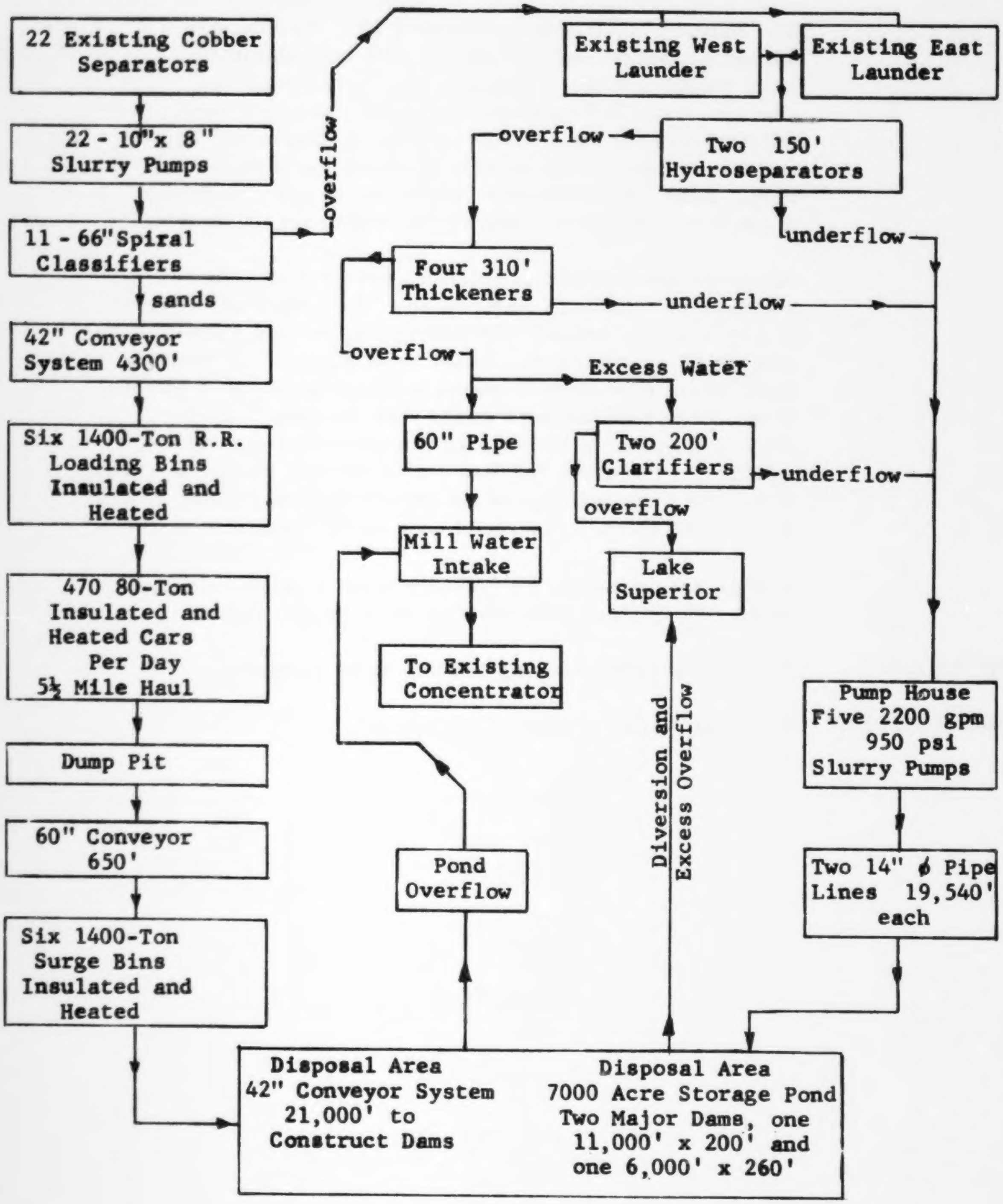
It does not appear to be feasible from a technical standpoint. No further engineering work is planned.

PROGRESS:	Preliminary engineering studies 100% complete.
TIMETABLE:	Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #6

"COARSE TAILINGS RAIL-HAULED TO LAX LAKE AREA ALL YEAR"


22 Existing Cobber Separators
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
sands
42" Conveyor System 4300'
Six 1400-Ton R.R. Loading Bins Insulated and Heated
470 80-Ton Insulated and Heated Cars Per Day 5½ Mile Haul
Dump Pit
60" Conveyor 650'
Six 1400-Ton Surge Bins Insulated and Heated
overflow
Existing West Launder
Existing East Launder
Two 150' Hydroseparators
overflow
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
60" Pipe
Two 200' Clarifiers
underflow
overflow
Mill Water Intake
Lake Superior
To Existing Concentrator
Diversion and Excess Overflow
Pond Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,540' each
Disposal Area 42" Conveyor System 21,000' to Construct Dams
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000' x 260'

PROPOSAL #7

"COARSE TAILINGS RAIL-HAULED TO LAX LAKE AREA SUMMER MONTHS ONLY"

ENGINEERING STUDY BY:
Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION: Coarse tailings would be transported to the Lax Lake area during the summer months only by rail and conveyor belt. A stockpile of coarse tailings would be built at the plant site during the winter months. The fine tailings would be thickened and pumped to a tailings basin in the Lax Lake area all year around.

Cobber magnetic separator tailings would be spiral classified into +35 and -35 mesh product. The rake (+35 mesh) tailings (about 50% of the total) would be conveyed to a storage pile on the delta in the winter at 18% moisture. During summer months these coarse tailings would be reclaimed from the delta stockpile, loaded along with similar size summer production material into bottom-dump rail cars and hauled to mile post 5½. From there they would be belt-conveyed to the Lax Lake area and spread with conveyors and stackers. The overflow from the spiral classifiers combined with the balance of the fine tailings would be fed into thickeners through existing launders. The thickener overflow would be returned to the plant as process water and the underflow pumped to the Lax Lake area and impounded behind dams constructed of coarse tailings. Tailings pond overflow would go back to the plant as process water and excess water would be clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION: Not included in the partial capital cost estimate of $49,400,000 are such items as land acquisition; financing and interest; inflation; spare parts; operating supplies; higher unit power costs due to additional power requirements; and mobile equipment other than railroad rolling stock.

Proposal #7

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$3,991,000
Depreciation	2,375,000
Interest	2,205,000
Total estimated average annual cost	$8,571,000

The conveyor system from the classifiers would have to be re-engineered before this system could be adopted. Also, at 18% moisture, much of the delta stockpile would be frozen so deep that reclaiming would be difficult even in the summer months.

The proposal does not appear to be sound from an environmental standpoint. The tailings basin would virtually destroy the Lax Lake area for its present uses--hunting, fishing, resorts and seasonal and year-around homes. Dust problems from blowing tailings could be expected to affect a wide area near the basin. This large tailings basin high upstream from the Beaver Bay-North Shore region could be a safety hazard. Also, very fine tailings would flow to Lake Superior from time to time via the Beaver River and Palisade Creek because of the necessity of diversion and/or overflow.

In addition, the technical feasibility of this proposal is questionable.

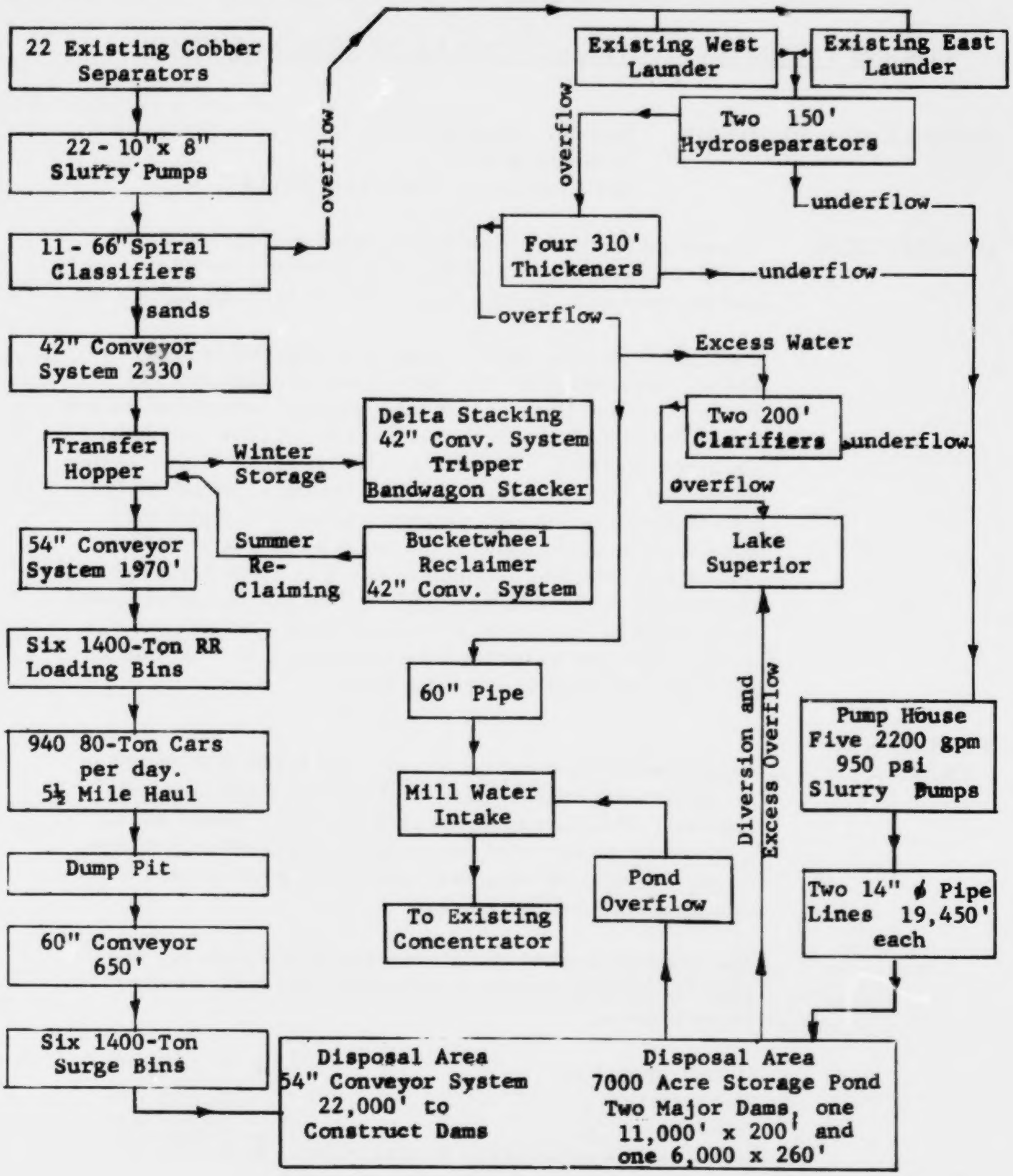
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #7

"COARSE TAILINGS RAIL-HAULED TO LAX LAKE AREA SUMMER MONTHS ONLY"


22 Existing Cobber Separators
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
overflow
sands
42" Conveyor System 2330'
Transfer Hopper
Winter Storage
Delta Stacking 42" Conv. System Tripper Bandwagon Stacker
Summer Re-Claiming
Bucketwheel Reclaimer 42" Conv. System
54" Conveyor System 1970'
Six 1400-Ton RR Loading Bins
940 80-Ton Cars per day. 5½ Mile Haul
Dump Pit
60" Conveyor 650'
Six 1400-Ton Surge Bins
Existing West Launder
Existing East Launder
Two 150' Hydroseparators
overflow
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
Two 200' Clarifiers
underflow
overflow
Lake Superior
60" Pipe
Mill Water Intake
To Existing Concentrator
Pond Overflow
Diversion and Excess Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,450' each
Disposal Area 54" Conveyor System 22,000' to Construct Dams
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000 x 260'

PROPOSAL #8

"COARSE TAILINGS CONVEYED TO LAX LAKE AREA ALL YEAR"

ENGINEERING STUDY BY:
Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION: Coarse tailings would be transported by belt conveyor to the Lax Lake area. Fine tailings would be thickened and pumped to a tailings basin also in the Lax Lake area.

Tailings from the cobber magnetic separators would be spiral classified into +35 mesh rake product and -35 mesh overflow fines. The rake product (about 50% of the total) would be belt-conveyed overland to the Lax Lake area and stacked. The spiral classifier overflow, combined with the balance of the fine tailings, would be fed into thickeners through existing launders. Thickener overflow would go back to the plant as process water. Underflow would be pumped to the Lax Lake area and impounded in the tailings basin. The tailings pond overflow would be returned to the plant and used as process water. Excess water would be clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION: Partial estimated capital costs of $48, 200, 000 do not include items such as land acquistion; financing and interest; inflation prior to construction; spare parts; higher unit power cost due to additional power requirements; operating supplies; and mobile equipment other than railroad rolling stock.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 3, 749, 000
Depreciation	2, 328, 000
Interest	2, 151, 000
Total estimated average annual cost	$ 8, 228, 000

The conveyor system from the classifiers requires re-engineering for satisfactory operation.

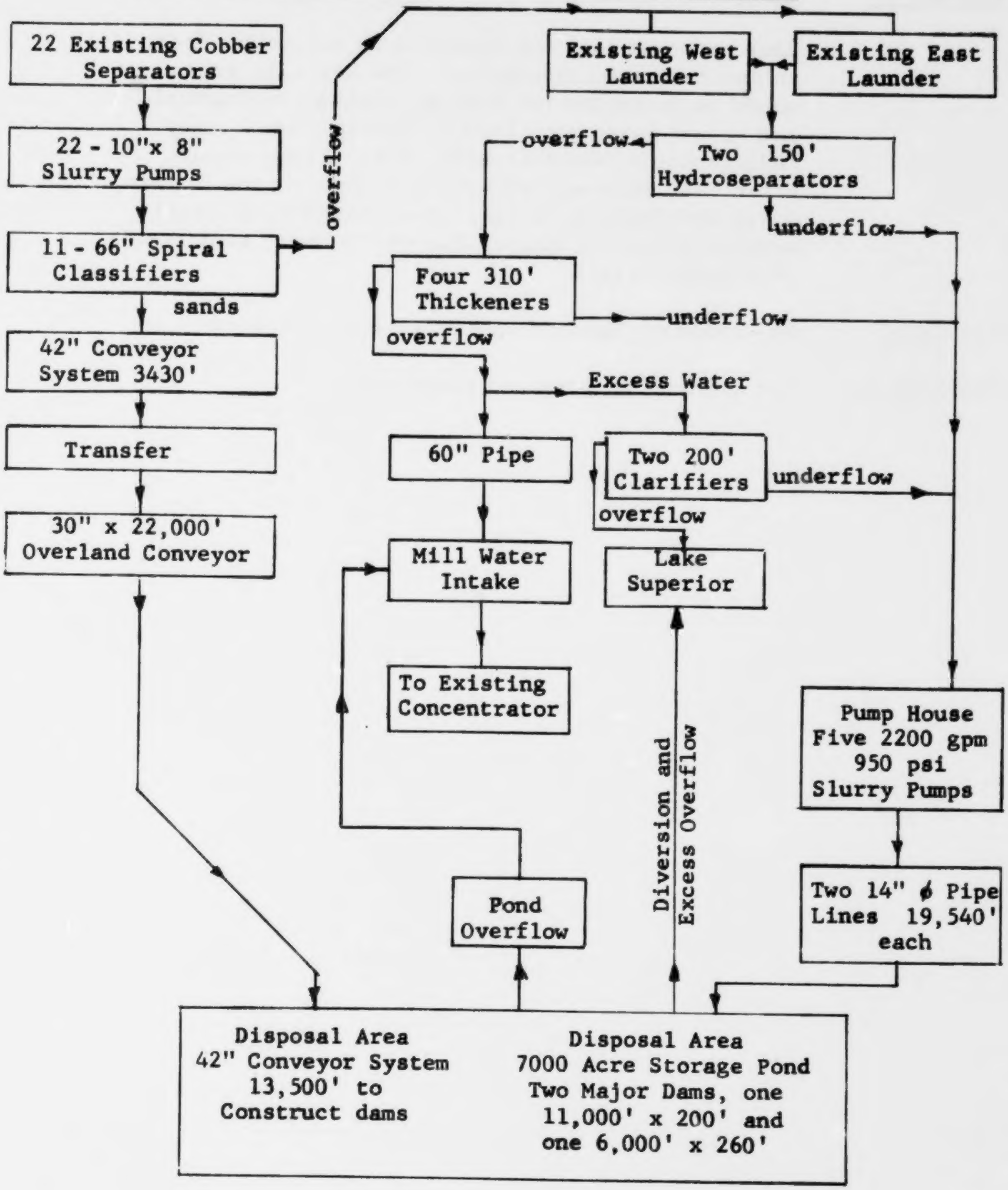
Proposal #8

This proposal does not appear to be acceptable from an environmental standpoint. The Lax Lake area would be destroyed for fishing, hunting, residential and resort purposes. Dust problems from blowing tailings would result as well. Fine tailings would enter Lake Superior from time to time via the Beaver River and Palisade Creek. Also, the tailings basin situated above the Beaver Bay-North Shore area could be a safety hazard.

PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET
PROPOSAL #8
"COARSE TAILINGS CONVEYED TO LAX LAKE AREA ALL YEAR"


22 Existing Cobber Separators
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
overflow
sands
42" Conveyor System 3430'
Transfer
30" x 22,000' Overland Conveyor
Existing West Launder
Existing East Launder
overflow
Two 150' Hydroseparators
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
60" Pipe
Two 200' Clarifiers
underflow
overflow
Mill Water Intake
Lake Superior
To Existing Concentrator
Diversion and Excess Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,540' each
Pond Overflow
Disposal Area 42" Conveyor System 13,500' to Construct dams
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000' x 260'

PROPOSAL #9

"COARSE TAILINGS CONVEYED TO LAX LAKE AREA SUMMER MONTHS ONLY"

ENGINEERING STUDY BY:

Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION: Coarse tailings would be conveyed during the summer months only by belt conveyors to the Lax Lake area. A stockpile of coarse tailings would be built at the plant site during the winter months. The fine tailings would be pumped to that area and impounded in a tailings basin.

Spiral classifiers would separate tailings into coarse (+35 mesh) and fine (-35 mesh) portions. The coarse, making up about half the total and containing about 18% moisture would be stockpiled on the delta during winter months, reclaimed during the summer and carried by conveyor belt to the Lax Lake area where it would be stacked. The fine portion would be fed into thickeners with the thickener overflow being sent back to the plant as process water. Thickener underflow--the fine portion of the tailings--would be pumped to the Lax Lake area and impounded behind dams built of coarse tailings. Tailings pond overflow would be returned to the plant as process water with the excess clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION: Partial estimates place the capital cost of such a proposal at more than $51,200,000 which does not include land acquistion; financial and interest charges; inflation prior to construction; spare parts; operating supplies; higher unit power cost due to additional power requirements; and mobile equipment other than railroad rolling stock.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 3,732,000
Depreciation	2,457,000
Interest	2,285,000
Total estimated average annual cost	$ 8,474,000

Proposal #9

The conveyor system from the classifiers would have to be re-engineered before this system could be considered. Also, at 18% moisture, much of the delta stockpile would be frozen so deep that reclaiming would be difficult even in the summer months.

The proposal does not appear to be sound from an environmental standpoint. It would create serious new problems because the Lax Lake area--a prime resort, fishing, hunting and residential region--would be covered with tailings. Blowing dust would be a problem. Fine tailings would, from time to time, enter Lake Superior via the Beaver River and Palisade Creek. Also, the tailings basin could be a safety hazard to the village of Beaver Bay and the Beaver River valley.

Further, the proposal's feasibility from a technical standpoint, is questionable.

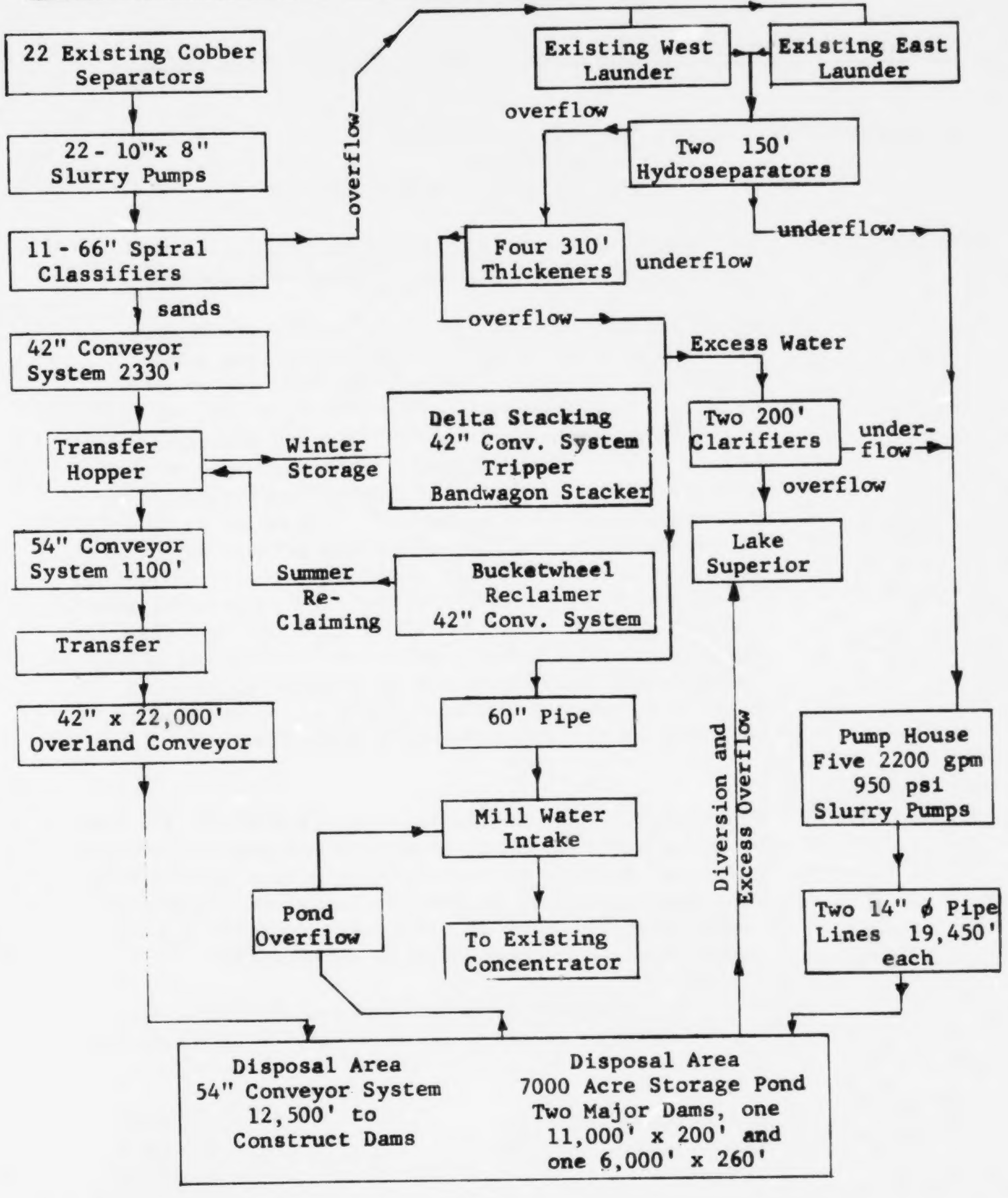
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #9

"COARSE TAILINGS CONVEYED TO LAX LAKE AREA SUMMER MONTHS ONLY"


22 Existing Cobber Separators
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
overflow
sands
42" Conveyor System 2330'
Transfer Hopper
Winter Storage
Delta Stacking 42" Conv. System Tripper Bandwagon Stacker
Summer Re-Claiming
Bucketwheel Reclaimer 42" Conv. System
54" Conveyor System 1100'
Transfer
42" x 22,000' Overland Conveyor
Existing West Launder
Existing East Launder
overflow
Two 150' Hydroseparators
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
Two 200' Clarifiers
under-flow
overflow
Lake Superior
60" Pipe
Mill Water Intake
Pond Overflow
To Existing Concentrator
Diversion and Excess Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,450' each
Disposal Area 54" Conveyor System 12,500' to Construct Dams
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000' x 260'

PROPOSAL #10

"COARSE TAILINGS RAIL-HAULED TO MILE POST 32 ALL YEAR"

ENGINEERING STUDY BY: Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION: This proposal would require rail-hauling coarse tailings to a point 32 miles northwest of Reserve's plant.

Spiral classifiers would separate cobber discharged tailings into a coarse (+35 mesh) product and a fine fraction of -35 mesh. The coarser fraction, about 50% of the total and containing about 18% moisture, would be conveyed to storage bins and then loaded into electrically heated, insulated railroad cars. The material would be rail-hauled to mile post 32 and spread on the ground by conventional stacking equipment. The spiral overflow combined with the balance of the fine tailings would be fed into thickeners through existing launders. Thickener overflow would be returned to the plant as process water. Underflow would be pumped to the Lax Lake area and impounded behind dams constructed from coarse tailings. Tailings pond overflow would be returned as process water to the plant and excess water would be clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION: Partial estimates for capital costs are $46,200,000, not including land acquistion; financing and interest charges; inflation; spare parts; operating supplies; and mobile equipment other than railroad rolling stock. Also, no money is provided for an additional power line and the higher power costs that would be encountered.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 4,731,000
Depreciation	2,095,000
Interest	2,062,000
Total estimated average annual cost	$ 8,888,000

Proposal #10

The environment of the region would be impaired by adoption of this proposal. Homes, both seasonal and year-round, as well as prime hunting, fishing, recreational and resort country would be covered by a large tailings basin. Lax Lake itself would cease to exist. Dust would be blown from the dry, exposed tailings and could affect a large area. Further, the Beaver Bay-North Shore area could be endangered by this tailings basin.

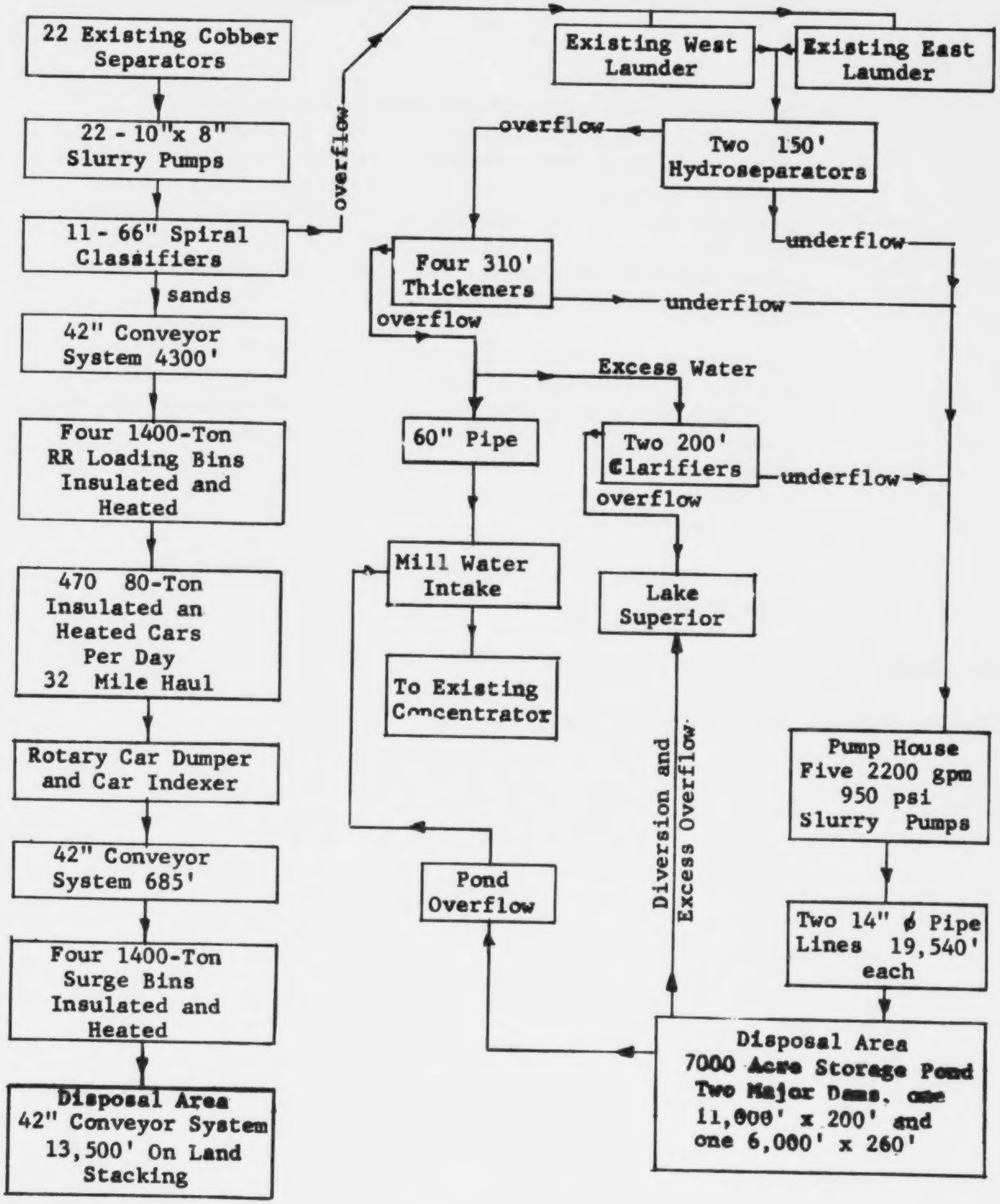
The transportation of 18% moisture tailings in winter weather would create many problems. The proposed electrically heated, insulated rail car is a new, untried concept. It would be necessary to conduct a sizable pilot test of these cars before this principle could be considered. Also the design of the conveyor system from the classifiers needs improvement.

The proposal's feasibility from a technical standpoint is questionable.

PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET
PROPOSAL #10
"COARSE TAILINGS RAIL-HAULED TO MILE POST 32 ALL YEAR"


22 Existing Cobber Separators
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
overflow
sands
42" Conveyor System 4300'
Four 1400-Ton RR Loading Bins Insulated and Heated
470 80-Ton Insulated an Heated Cars Per Day 32 Mile Haul
Rotary Car Dumper and Car Indexer
42" Conveyor System 685'
Four 1400-Ton Surge Bins Insulated and Heated
Disposal Area 42" Conveyor System 13,500' On Land Stacking
Existing West Launder
Existing East Launder
overflow
Two 150' Hydroseparators
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
60" Pipe
Two 200' Clarifiers
underflow
overflow
Mill Water Intake
To Existing Concentrator
Lake Superior
Diversion and Excess Overflow
Pond Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,540' each
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000' x 260'

PROPOSAL #11

"COARSE TAILINGS RAIL-HAULED TO MILE POST 32 SUMMER MONTHS ONLY"

ENGINEERING STUDY BY: Bechtel Corporation
50 Beale Street
San Francisco, California 94119

DESCRIPTION: Total tails would be divided by spiral classifiers into two portions of approximately equal volume; one made up of coarse material (+35 mesh), the other of fines. The coarse half, containing about 18% moisture, would be stockpiled on the delta during the winter. During the summer, this material would be reclaimed and rail-hauled to a point 32 miles northwest of the plant on Reserve's railroad and stacked on the ground.

Classifier overflow, combined with the balance of the fine tailings, would be thickened and pumped to the Lax Lake area where the material would be impounded in a tailings basin formed by dams made of coarse tailings. Thickener overflow and tailings pond overflow would be returned to the plant as process water. Excess water would be clarified to less than 25 JTU and returned to Lake Superior.

PRELIMINARY EVALUATION: Partial estimated capital costs of $54,300,000 do not include land acquisition; financing and interest costs; higher unit power cost due to additional power requirements; inflation; spare parts; operating supplies; mobile equipment.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$ 4,798,000
Depreciation	2,492,000
Interest	2,423,000
Total estimated average annual cost	$ 9,713,000

Proposal #11

The proposal would result in serious environmental problems because the Lax Lake area, a prime resort, fishing, hunting and residential region, would be the tailings basin site. Overflow of the tailings basin, from time to time, would carry fine tailings into Lake Superior via Beaver River and Palisade Creek. Blowing dust would be a problem. Also, the huge tailings basin perched above the residences of the Beaver River valley, including the Village of Beaver Bay, could be a safety hazard.

Technical problems as yet unsolved include: conveyor system from the classifiers is not satisfactory as designed; also at 18% moisture, much of the delta stockpile would be frozen so deep that reclaiming even in summer months would be difficult.

This proposal's feasibility from a technical standpoint is questionable.

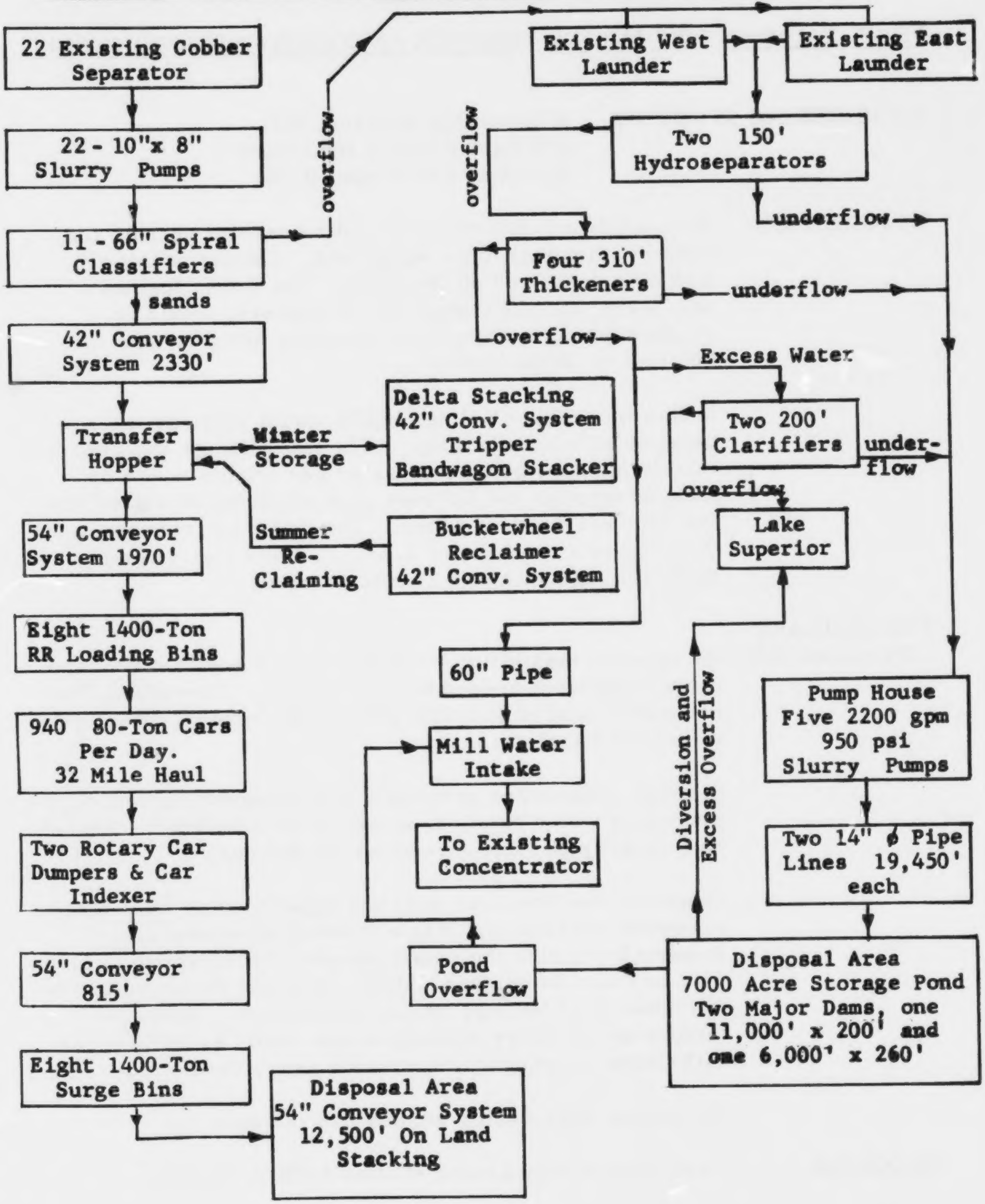
PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

FLOW SHEET

PROPOSAL #11

"COARSE TAILINGS RAIL-HAULED TO MILE POST 32 SUMMER MONTHS ONLY"


22 Existing Cobber Separator
22 - 10"x 8" Slurry Pumps
11 - 66" Spiral Classifiers
overflow
sands
42" Conveyor System 2330'
Transfer Hopper
Winter Storage
Delta Stacking 42" Conv. System Tripper Bandwagon Stacker
Summer Re-Claiming
Bucketwheel Reclaimer 42" Conv. System
54" Conveyor System 1970'
Eight 1400-Ton RR Loading Bins
940 80-Ton Cars Per Day. 32 Mile Haul
Two Rotary Car Dumpers & Car Indexer
54" Conveyor 815'
Eight 1400-Ton Surge Bins
Disposal Area 54" Conveyor System 12,500' On Land Stacking
Existing West Launder
Existing East Launder
Two 150' Hydroseparators
overflow
underflow
Four 310' Thickeners
underflow
overflow
Excess Water
Two 200' Clarifiers
under-flow
overflow
Lake Superior
60" Pipe
Mill Water Intake
To Existing Concentrator
Diversion and Excess Overflow
Pump House Five 2200 gpm 950 psi Slurry Pumps
Two 14" ϕ Pipe Lines 19,450' each
Pond Overflow
Disposal Area 7000 Acre Storage Pond Two Major Dams, one 11,000' x 200' and one 6,000' x 260'

PROPOSAL #12

"FINE TAILINGS DISCHARGED THROUGH AN UNDERWATER DIFFUSER"

ENGINEERING STUDY BY: Engineering-Science, Inc.
150 East Foothill Boulevard
Arcadia, California 91006

DESCRIPTION: Fine tailings (-500 mesh) would be separated from the total by thickener-type equipment. Coarse tailings would be deposited on the delta. The fines, together with water overflow from the thickeners, would be pumped through a nine-foot diameter diffuser pipe into 300 feet or deeper water.

In this manner, a tailings beach would continue to grow because of coarse tailings. The fine tailings and approximately 300,000 gallons of water per minute would be pumped through the diffuser pipe which would extend into the 300-foot depth of water. The material from the pipe would have a turbidity of 2,560 JTU and would be essentially all -500 mesh or 25 micron size.

PRELIMINARY EVALUATION: No detailed feasibility study has been made to determine other equipment needed by this system. Therefore, the estimated cost of $10,000,000 for thickeners and diffuser is very incomplete.

Several alternative proposals are suggested to reduce the amount of water handled, allowing for smaller thickeners and outfall pipes and a reduced capital cost.

However, the proposal does not appear sound from a conservation standpoint. While it would eliminate or materially reduce the small amount of fine tailings which may be found in surface waters, it would result in a wide distribution of tailings on the lake bottom. Also, the temporary turbidity in deep waters would exceed the low turbidities existing in the present heavy density current.

No further engineering studies are planned.

PROGRESS: Preliminary engineering studies 100% complete.

TIMETABLE: Not applicable; proposal abandoned.

PROPOSAL #13

"LAKE SHORE TAILINGS POND"

ENGINEERING STUDY BY: Parsons-Jurden Corporation
26 Broadway
New York City, New York

DESCRIPTION: Under this proposal, a "dike" of coarse tailings would be built along the shore line. Its base would be the 100-foot deep contour line and would extend for 7,000 feet northeast of the present delta. This new "diked-in" area (the existing delta plus 7,000 feet of new delta, together with the natural shore up to 100 feet from Highway #61) would be used for deposit of our total tailings production behind the "dike" impoundment.

Tailings would be hydroseparated into coarse hydroseparator underflow (+150 mesh) and fine hydroseparator overflow (-150 mesh) fractions. The hydroseparator overflow would flow into thickeners. Thickener overflow would be returned to the plant as process water. The coarse fraction would be pumped to the delta edge to build a tailings dike by means of cyclone classifiers. The underflow (fines) would be pumped to the delta edge also building the dike by means of clones. Coarse tailings would be spigot-discharged on the lake side of the dike to build a spending beach to protect the dike from wave action. Likewise, spigots would discharge excess coarse tailings just inside the 100-foot lake bottom contour to build a 50-foot wide tailings dike in the water. When the dike is extended sufficiently, a tailings impoundment would be built over the remaining shallow water up to the lake shore, continuing on shore to within 100 feet of Highway #61. Decanting towers would drain the water from within this long tailings impoundment into the harbor for returning through existing pump system as process water.

PRELIMINARY EVALUATION: The proposal would completely eliminate the discharge of any tailings to the lake other than the coarse tailings (+150 mesh) required to build the dikes and spending beaches to protect the dikes.

Proposal #13

However, it presents some very undesirable features.

It would necessitate relocation of both the Silver Bay municipal sewage and water treatment plants.

It would be very unsightly despite our best efforts to plant the face of the dikes and the delta with grasses and trees. The impoundments would be very high and visible for miles along the shore.

After 30 years of operation, the basin would be 280 feet above the lake level. Also, only about half the fine tailings in the ponds would be covered with water at one time. This would result in severe and uncontrollable blowing dust over a wide area including the North Shore highway and the entire communities of Silver Bay, East Beaver Bay and Beaver Bay.

The estimated partial capital cost of this proposal is $27,449,000. The estimated cost of relocating the municipal sewage and water treatment plants is $3,920,000. The total estimated partial capital cost is $31,369,000. Those estimates do not include the cost of land acquisition; higher unit power cost due to additional power requirements; financing, interest and inflation until completion of construction.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$2,899,500
Depreciation	1,178,000
Interest	1,400,000
Total estimated average annual cost	$5,477,500

The principle of high tailings basins built in areas of little or no water shed drainage should be investigated further. Also, means of dust control need to be studied.

PROGRESS: Preliminary engineering studies, as originally planned, 100% complete.

TIMETABLE: On April 3, a meeting with Parsons-Jurden was arranged for April 10, 1970, to discuss additional study on this basic principle.

April 9, 1970
Revised August 10, 1970

Proposal #13

However, it presents some very undesirable features.

It would necessitate relocation of both the Silver Bay municipal sewage and water treatment plants.

It would be very unsightly despite out best efforts to plant the face of the dikes and the delta with grasses and trees. The impoundments would be very high and visible for miles along the shore.

After 30 years of operation, the basin would be 280 feet above the lake level. Also, only about half the fine tailings in the ponds would be covered with water at one time. This would result in severe and uncontrollable blowing dust over a wide area including the North Shore highway and the entire communities of Silver Bay, East Beaver Bay and Beaver Bay.

The estimated partial capital cost of this proposal is $27,449,000. The estimated cost of relocating the municipal sewage and water treatment plants is $3,920,000. The total estimated partial capital cost is $31,369,000. Those estimates do not include the cost of land acquisition; higher unit power cost due to additional power requirements; financing, interest and inflation until completion of construction.

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$2,899,500
Depreciation	1,178,000
Interest	1,400,000
Total estimated average annual cost	$5,477,500

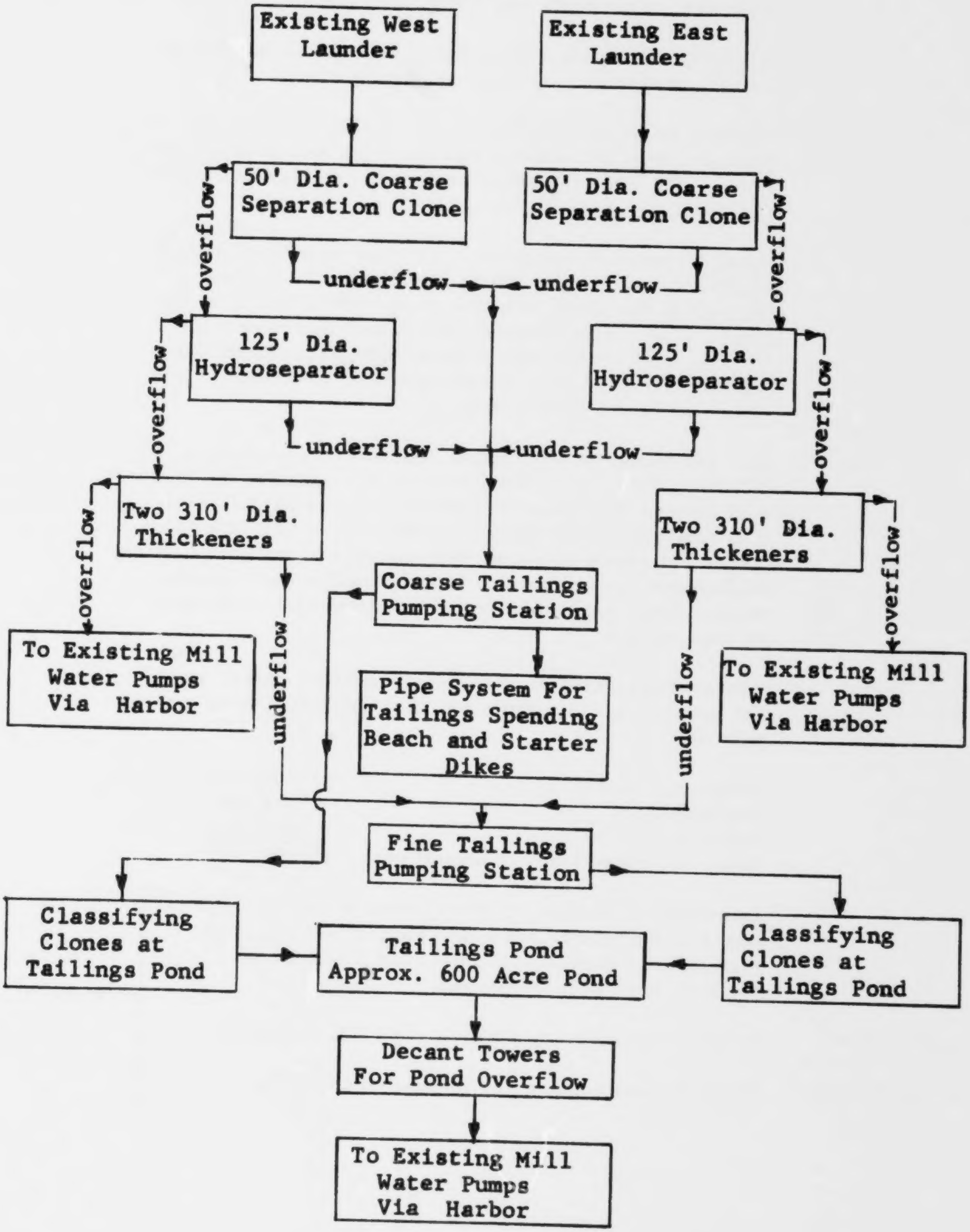
Investigation showed no other areas of little or no watershed drainage are available for building such high tailings basins. No improved dust control methods have been developed.

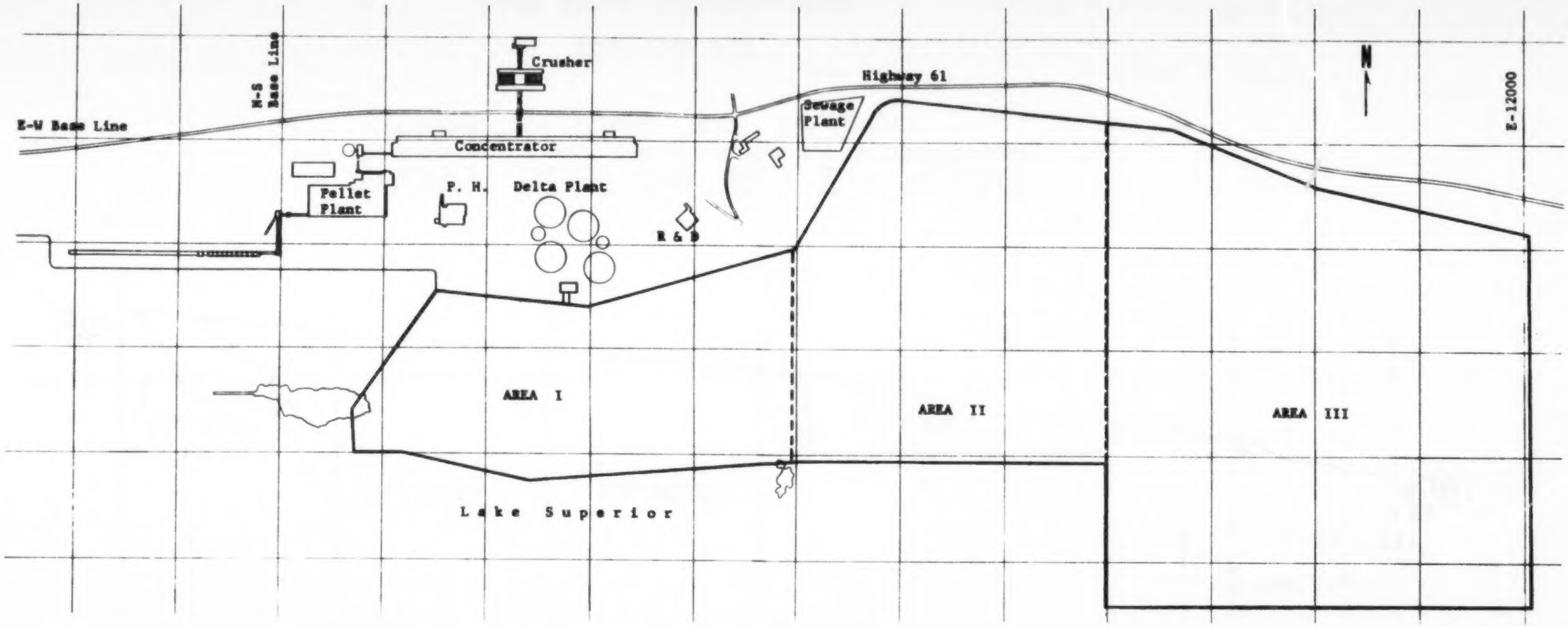
PROGRESS: Original preliminary engineering 100% complete.

TIMETABLE: No additional engineering planned at this time.

8-10-70

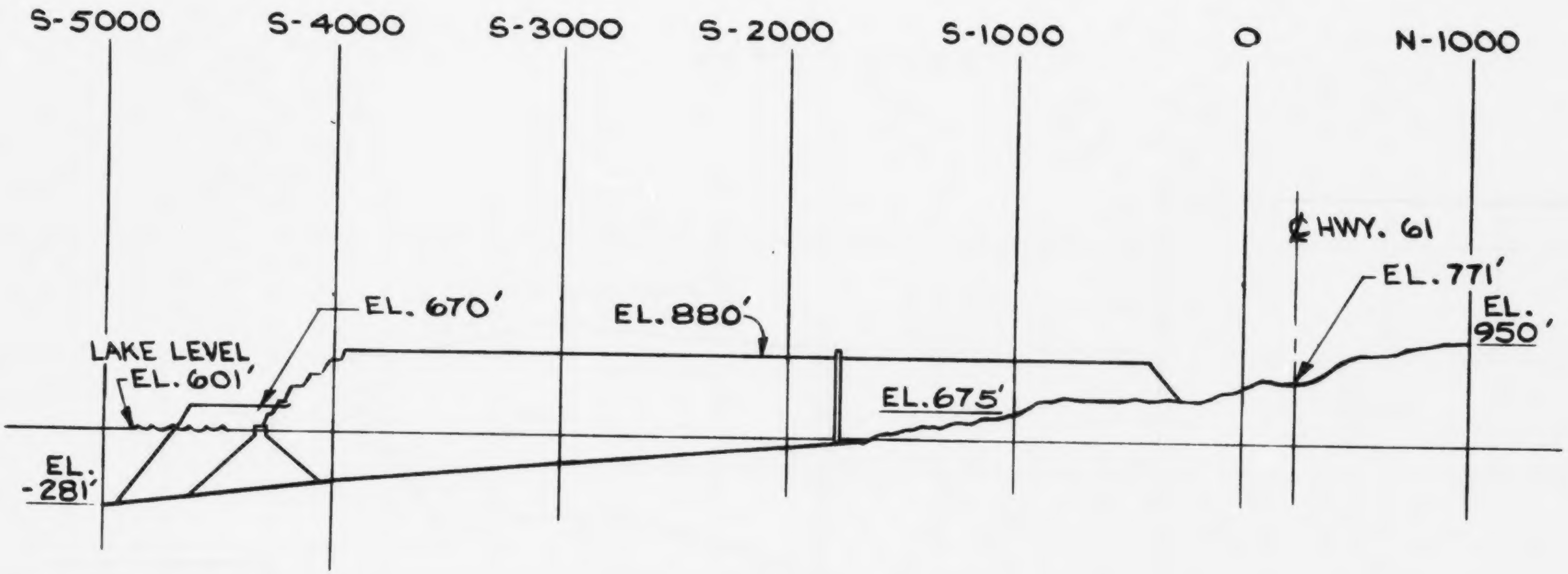
FLOW SHEET
PROPOSAL #13
"LAKE SHORE TAILINGS POND"


Existing West Launder
Existing East Launder
50' Dia. Coarse Separation Clone
50' Dia. Coarse Separation Clone
overflow
underflow
underflow
overflow
125' Dia. Hydroseparator
125' Dia. Hydroseparator
overflow
underflow
underflow
overflow
Two 310' Dia. Thickeners
Two 310' Dia. Thickeners
overflow
Coarse Tailings Pumping Station
overflow
To Existing Mill Water Pumps Via Harbor
underflow
Pipe System For Tailings Spending Beach and Starter Dikes
underflow
To Existing Mill Water Pumps Via Harbor
Fine Tailings Pumping Station
Classifying Clones at Tailings Pond
Tailings Pond Approx. 600 Acre Pond
Classifying Clones at Tailings Pond
Decant Towers For Pond Overflow
To Existing Mill Water Pumps Via Harbor


Crusher
N-S Base Line
E-W Base Line
Concentrator
Highway 61
Sewage Plant
N
E-12000
Pellet Plant
P. H.
Delta Plant
R & D
AREA I
AREA II
AREA III
Lake Superior

P L A N   V I E W

PROPOSAL #13
LAKE SHORE TAILINGS POND


S-5000
S-4000
S-3000
S-2000
S-1000
0
N-1000
℄ HWY. 61
EL. 771'
EL. 950'
EL. 670'
EL. 880'
LAKE LEVEL
EL. 601'
EL. 675'
EL. -281'

CROSS SECTION @ E - 9000

FROM S-5000 TO N-1000

PROPOSAL #13

LAKE SHORE TAILINGS POND

PROPOSAL #14

"THICKENED COARSE TAILINGS DELTA"

ENGINEERING STUDY BY: Parsons-Jurden Corporation
26 Broadway
New York City, New York

DESCRIPTION: Coarse tailings would be piped in a manner designed to retain more tailings on the beach than current practice. Thickened fines (-150 mesh) would be pumped through a submerged pipe into 150-feet deep water.

Tailings would be hydroseparated into coarse (+150 mesh) and fine (-150 mesh) fractions with the fine fraction thickened and the overflow returned to the plant as process water. The thickened coarse tailings, hydroseparator underflow, would be pumped through ten or more pipes buried beneath the surface of the delta which would be built up to a level about 25 feet higher than the surface of the lake. The tailings would accumulate below each discharge until the discharge is nearly choked off. Pipes would then be extended another ten feet or more. By piping tailings to each end of the beach, the ends would be built up in advance of the center. Rock dikes then would be added at each end on top of the tailings, or the ends of the beach could be protected with pilings driven into the tailings. The fine tailings fraction would be pumped through a submerged pipe into 150 feet of water.

PRELIMINARY EVALUATION: More tailings would remain on the delta than at present--a material reduction (27%) of tailings discharged into the lake. All fines would be discharged below any surface-affecting thermocline, thereby eliminating or materially reducing the small amount of fines which may, under certain conditions, be found in surface waters. Also, by controlling the shape of the delta to a concave, the chances of fines being generated by wave action would be greatly reduced.

The entire delta could be landscaped to within 20 or 30 feet of the lake edge through continuous grass and tree plantings, enhancing the appearance of the delta. There would be no unsightly flow over the delta.

The partial estimated capital costs of $11,620,000 do not include higher unit power cost due to additional power requirements, or financing, interest and inflation costs until the completion of construction.

Proposal #14

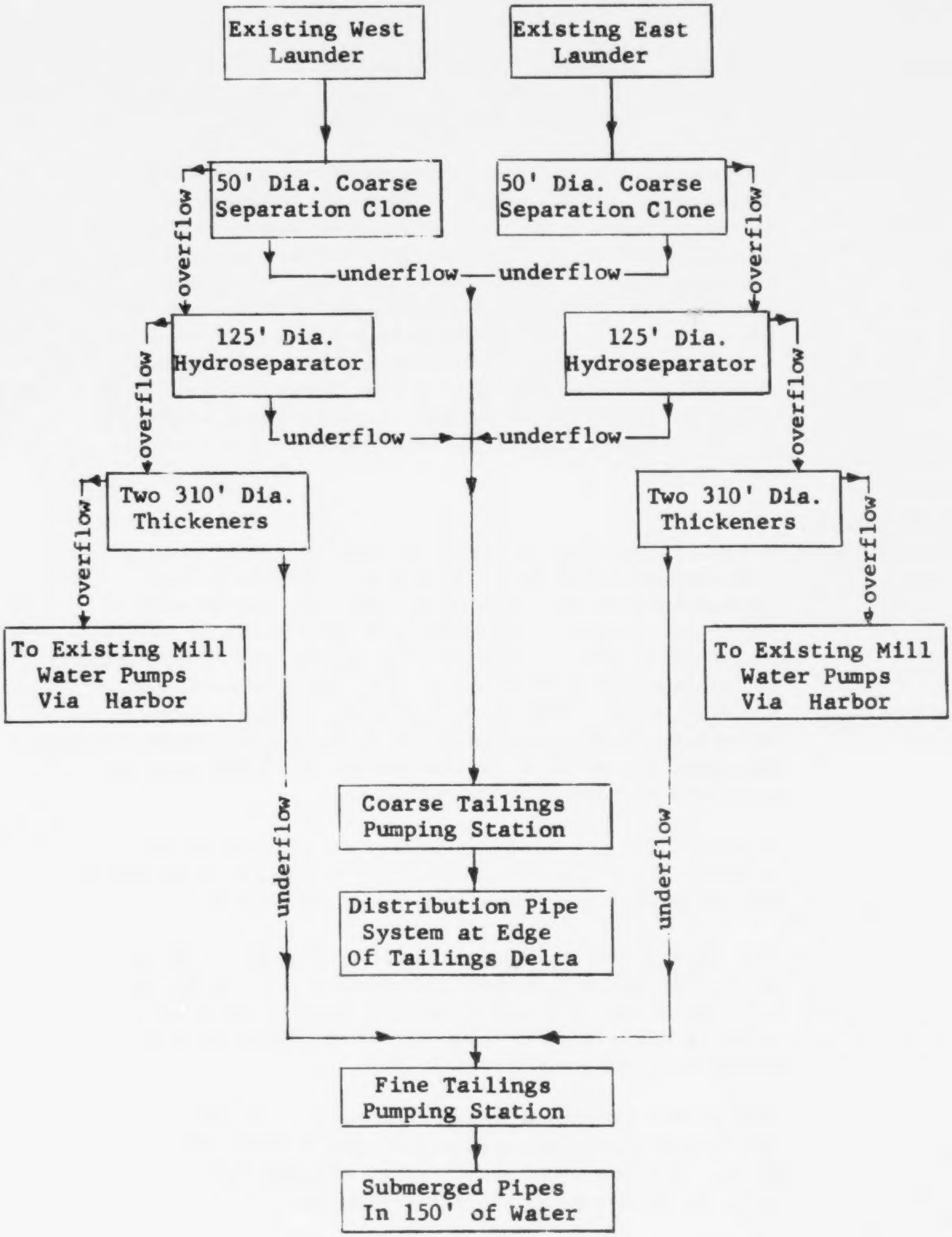
The average annual costs over the next 20 years, except for escalation due to inflation are estimated to be as follows:

Direct operating	$1,185,850
Depreciation	519,000
Interest	519,000
Total estimated average annual cost	$2,228,850

PROGRESS: Preliminary engineering 100% complete.

TIMETABLE: Ready for detailed engineering.

FLOW SHEET
PROPOSAL #14
"THICKENED COARSE TAILINGS DELTA"


Existing West Launder
Existing East Launder
50' Dia. Coarse Separation Clone
50' Dia. Coarse Separation Clone
overflow
overflow
underflow
underflow
125' Dia. Hydroseparator
125' Dia. Hydroseparator
overflow
overflow
underflow
underflow
Two 310' Dia. Thickeners
Two 310' Dia. Thickeners
overflow
overflow
To Existing Mill Water Pumps Via Harbor
To Existing Mill Water Pumps Via Harbor
underflow
underflow
Coarse Tailings Pumping Station
Distribution Pipe System at Edge Of Tailings Delta
Fine Tailings Pumping Station
Submerged Pipes In 150' of Water

PROPOSAL #15

"UNDERWATER SAND REEF BENEFICIAL TO BOTTOM FAUNA AND FISH"

ENGINEERING STUDY BY: Parsons-Jurden Corporation
26 Broadway
New York City, New York

DESCRIPTION: Hydroseparators and thickeners would thicken tailings discharge to 40-60% solids. Thickener overflow would be recirculated to the plant as process water. Thickened tailings would be pumped through a number of pipes, the buoyancy of which is controlled to "float" them at 140 feet below the lake's surface when full of 40% solid slurry. When the lake bottom builds up to 150 feet in front of a pipe, water with sufficient trapped air would be pumped through it to cause that pipe to rise to the surface. An extension could then be added. Tailings would be pumped through it again causing it to sink back down to the 140-foot depth.

PRELIMINARY EVALUATION: Waters deeper than 400 feet are very sparse in bottom fauna on which fish feed. At depths of 100 to 150 feet, these bottom fauna are at their maximum population. Therefore, creating an underwater sand beach or reef at this depth would improve the food supply for valuable species of fish in the vicinity of Silver Bay. Such an area of plentiful fish food and excellent fishing sites is scarce along the Minnesota shore since the water reaches great depths so near the shore and because the lake bottom has little sand by comparison to the Wisconsin shore.

Further, this proposal would place all tailings below any surface-affecting thermocline so no tailings from Reserve's discharge should be found in any surface waters.

The edge of the present above-water delta would be stabilized with clusters of sheet piling cells to allow the planting of flowers, grasses and trees. No tailings would be seen entering the lake and tailings from the discharge would not be found in surface waters.

The partial estimated capital cost of $12,740,000 does not include higher unit power cost due to additional power requirements, or financing, interest and inflation costs to the completion of construction.

Proposal #15

The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$1,123,000
Depreciation	532,000
Interest	569,000
Total estimated average annual cost	$2,224,000

PROGRESS: Preliminary engineering 100% complete.

TIMETABLE: Ready for detailed engineering.

April 9, 1970
Revised August 10, 1970

Proposal #15

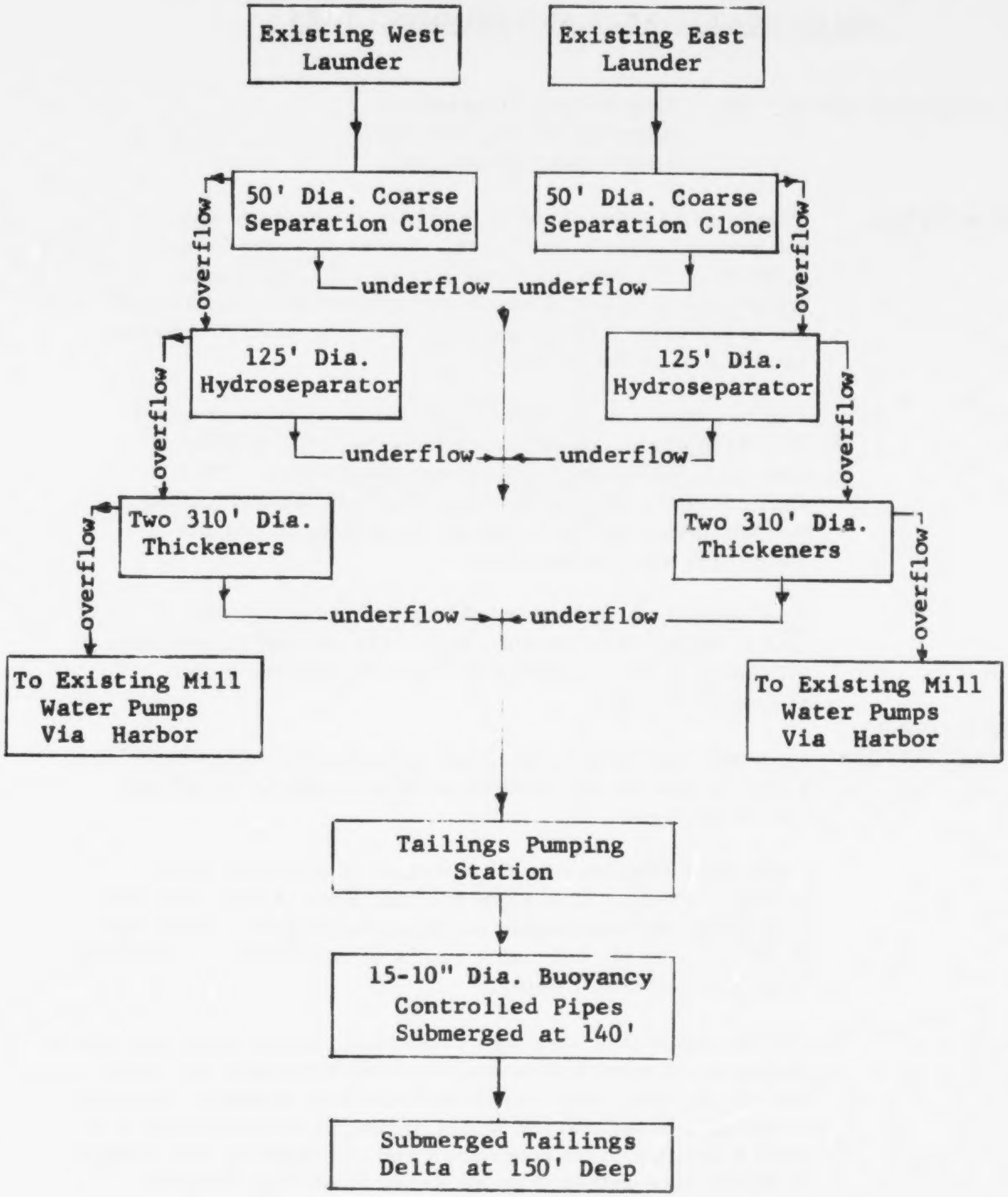
The average annual costs over the next 20 years, except for escalation due to inflation, are estimated to be as follows:

Direct operating	$1,123,000
Depreciation	532,000
Interest	569,000
Total estimated average annual cost	$2,224,000

PROGRESS: Preliminary engineering 100% complete.

TIMETABLE: Pilot plant tailings to be pumped 150 feet below the surface of Lake Superior, creating an underwater reef. 8-10-70

FLOW SHEET
PROPOSAL #15
"UNDERWATER SAND REEF BENEFICIAL TO BOTTOM FAUNA AND FISH"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Two 310' Dia. Thickeners
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underflow
underflow
To Existing Mill Water Pumps Via Harbor
To Existing Mill Water Pumps Via Harbor
Tailings Pumping Station
15-10" Dia. Buoyancy Controlled Pipes Submerged at 140'
Submerged Tailings Delta at 150' Deep

PROPOSAL #16

"SMALL BOAT HARBOR AND SWIMMING AREA"

ENGINEERING STUDY BY: Engineering Department
Reserve Mining Company
Silver Bay, Minnesota

DESCRIPTION: This would be developed for public recreation west of the present west breakwater. Tailings would be used to build up the bottom of the bay to a 15-foot depth. A spending beach would be constructed on the east side of the breakwater. Tailings also would be used to make a sand beach at the shore.

The bay would be closed except for a small boat entry by a breakwater constructed from Mattson's Point to near Gull Island (see accompanying sketch). This shallow enclosed bay would be the only location along the Minnesota North Shore warm enough to permit swimming all summer long.

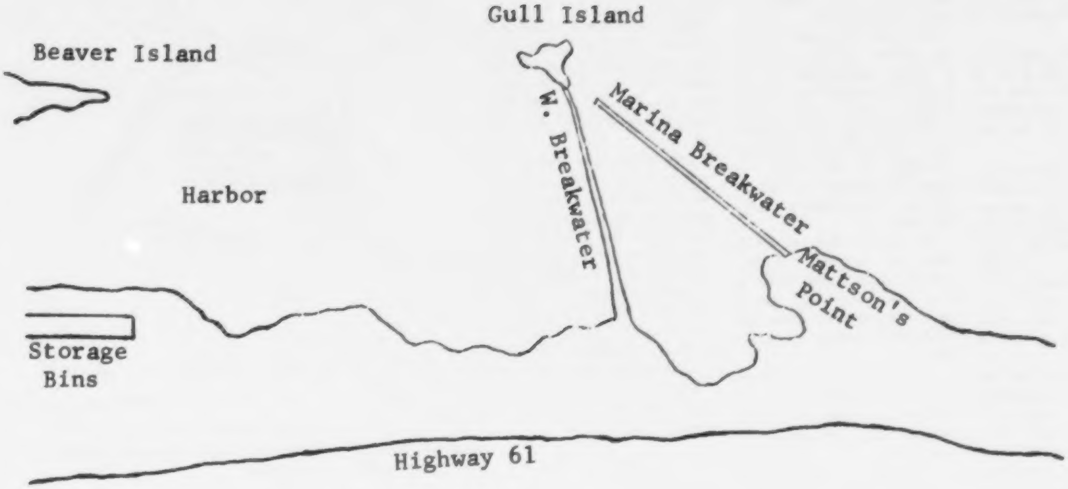
Boat launching ramps, docks, paved parking lots, paved roads, landscaping, etc., are needed to complete this project as a unique and much-needed park and recreational area.

PRELIMINARY EVALUATION: This will not dispose of much tailings, but is nevertheless a worthwhile project and constitutes another beneficial use of tailings.

Reserve's Engineering Department is making a preliminary study. It is expected that about 5,500,000 tons of tailings will be needed to raise the bottom of this bay to 15 feet and 90,000 cubic yards of rock will be needed to build the new breakwater.

NOTE: Since this idea was conceived, local, state and federal government agencies have announced a project somewhat similar to this, also based on the use of tailings. A news clipping is attached. It would appear more desirable for such a facility to be controlled and operated by the Village of Silver Bay rather than by Reserve Mining Company. Reserve will cooperate with the appropriate governmental agencies in every practicable way--including transfer of title to the property along the shore without cost.

Proposal #16


Gull Island
Beaver Island
W. Breakwater
Marina Breakwater
Harbor
Mattson's Point
Storage Bins
Highway 61

Area Interest Grows In Small Boat Harbors

Duluth News-Tribune 2-1-70

BY ARVID MORKEN

Of The News-Tribune Staff

Twenty - six years have passed since the U.S. Army Corps of Engineers recommended that small boat harbors be constructed at 30-mile intervals along the shores of Lake Superior.

Those 1944 documents have since gathered quite a bit of dust but have not been forgotten. The plan now appears to be a sound one; but two decades premature.

Because of a series of recent developments and coordinated efforts among several levels of government, it would not be unthinkable for small boat enthusiasts to consider the purchasing of new charts and the plotting of new courses out on that big lake, which has the coldest blue eyes in creation.

Local dollars toward the construction cost of recreational harbors were not made available for a considerable time after the Corps recommendations came along and most plans were filed in the bottom of desk drawers from Minnesota to Michigan. Meanwhile, the Corps classified its proposals as "inactive due to local interest."

But then people in Michigan created a state waterways commission which became an instrument to fund (among other projects) the small boat harbors urged by the Corps.

Minnesota, which had harbors at Duluth, Two Harbors and Grand Marais in 1944, was asked to provide new facilities at Knife River, Beaver Bay and the Poplar River. In the 20 years that followed, only the Knife River harbor became a reality.

Wisconsin, during the same period, added only Saxon to earlier small boat refuges in Superior, Port Wing, Cornucopia and Bayfield.

However, the change in Minnesota began two years ago when Gov. Harold LeVander blew dust off the Corps reports and looked for ways to implement the recommendations. More bottom drawers were emptied and state legislators were soon studying the 1944 proposals with village officials. More impetus came from John B. Arnold of Duluth after LeVander appointed him as his representative to the Upper Great Lakes Regional Commission.

"I'm glad the state is taking interest in our report," a Duluth spokesman for the Corps commented last week, "because those people down in Michigan got quite a head start." He credited Arnold with providing "a big push" toward the proposed network of harbors approximately every 30 miles.

The chicken and egg situation that retarded construction of small boat facilities over the years has largely been overcome by these developments, harbor supporters say:

—Advent of Minnesota's Coho Salmon program;

—Lamprey control in Lake Superior and resurgence of lake trout;

—Increasing emphasis on recreational facilities to serve area citizens and larger numbers of tourists;

—Construction of an interstate highway system that will make possible the towing of pleasure craft to Lake Superior at highway speeds from throughout the state.

Another significant development occurred during the past legislative session when Minnesota lawmakers passed a bill authorizing the state to assume 50 per cent of the local costs in constructing harbors recommended by the Corps.

Passage of that bill not only spurred greater consideration toward harbor facilities at locations suggested by the Corps, it prompted new planning in communities which had docks for small boats before 1944.

Developments toward construction of marinas and public docking facilities taken at all Minnesota sites programmed for the harbor network are outlined in a report released earlier this month by Arnold for the three-state regional commission. They are as follows:

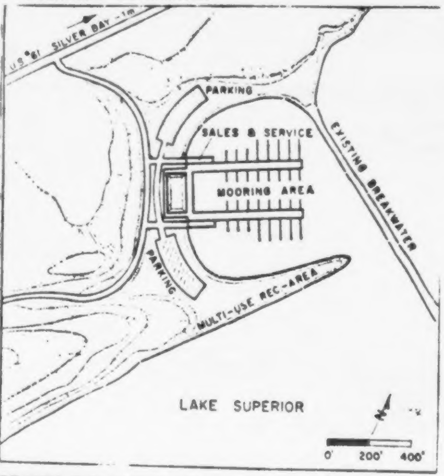
(Duluth-Superior, Knife River, Poplar River, Grand Marais omitted)

BEAVER BAY

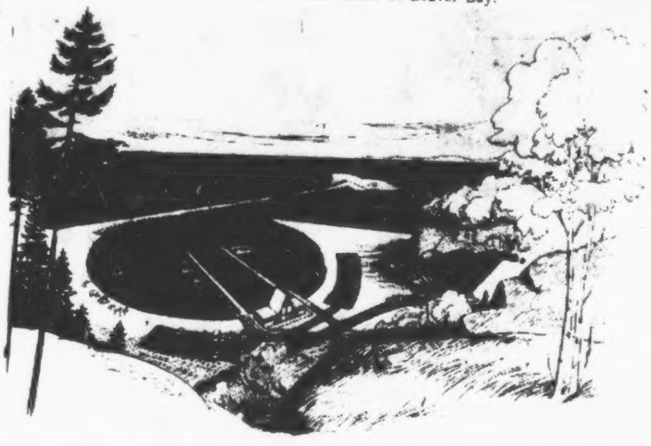
LeVander has asekd the Corps to reinstate Beaver Bay's recommendation for harbor construction, but to move the proposed site due to shoreline changes since 1944.

The project would be around a corner from the earlier site and would utilize the breakwater built by Reserve Mining Co., within the jurisdiction of the Village of Silver Bay.

The village has shown interest in the plan and has sent a resolution to the Corps indicating its intent to share local costs and provide information required to implement the 1944 recommendation. Preliminary drawings of the harbor plan have been offered and the commission describes cooperation between the governor's office, Corps and the village as "excellent and a fine example of inter-governmental relationships."



BEAVER BAY PLANS — This map shows proposed plans for small boat harbor at Beaver Bay.



HILLSIDE VIEW — The Beaver Bay harbor being planned may appear from a vantage point along Highway 61 as shown in the above sketch.

PROPOSAL #17

"DRY COBBING OF ROD MILL FEED"

ENGINEERING STUDY BY:

Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: Under this proposal, tailings would be dry cobbed from rod mill feed, reducing the discharge of total tails to the lake by as much as 30%.

Separation would be made using a permanent magnet, high intensity high RPM drum which was manufactured only recently. This test drum--which has, until only recently, been under study and evaluation by the University of Minnesota Mines Experiment Station--was installed in Reserve's pilot plant March 2nd. It began round-the-clock operation March 9th to obtain operating information and basic data needed to perform engineering feasibility studies.

PRELIMINARY EVALUATION: Preliminary laboratory-scale tests indicate that perhaps as much as 30% of the tailings can be removed before the material enters the rod mills and before any water is used in the process. The dry tailings removed would be both fine and coarse and would be deposited on land at some suitable location--perhaps even near the mine at Babbitt. Though only meager pilot plant data is available, Reserve has commissioned Trygve Hoff to make preliminary studies of several potential installations of this type of equipment and methods of disposing of the dry tailings. The results of the pilot plant work should produce a more accurate estimate of the amount of dry tailings that can be removed.

PROGRESS: 15 to 20% complete.

TIMETABLE: Preliminary engineering data and cost estimates expected in about 60 days.

April 9, 1970
Revised August 10, 1970

PROPOSAL #17

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Trygve Hoff & Associates
1922 East 107th Street
Cleveland, Ohio 44106

Parsons-Jurden Corporation
26 Broadway
New York, N. Y. 10004

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PRELIMINARY EVALUATION: Several months of pilot plant operation has established the following:

1. Approximately 30% of the tailings can be removed by dry cobbing.
2. Freezing test and other data indicate that this dry coarse tailings can be handled by conventional equipment even during winter weather.
3. Sufficient engineering data for preliminary engineering of production plant installations of dry cobbing equipment.
4. That it will be necessary to make a number of significant changes in the concentrating flowsheet of equipment to accommodate the dry cobbing step.

Trygve-Hoff and Associates made a preliminary engineering study of installing dry cobbing equipment as a part of each line of concentrating equipment or concentrating section. This study also included all equipment to handle the dry cobbed tailings into storage bins from which the dry tailings would be loaded into railroad cars.

8-10-70

Proposal #17

April 9, 1970
Revised August 10, 1970

The partial estimated capital cost of this installation is estimated to be $20,922,000 and does not include such items as facilities to transport the dry tailings to their final disposal area; financing and interest cost; escalation to date of construction; field engineering; and instrumentation.

Parsons-Jurden Corporation made a preliminary engineering study of performing this dry cobbing operation as a separate operation between the crushing and concentrating steps.

Equipment is not included to handle the dry cobbed tailings into storage bins from which the dried tailings will be loaded into railroad cars.

The estimated partial capital cost of these facilities is $15,025,000. This estimate does not include the cost of facilities to transport the dry tailings to the final disposal area, land acquisition; higher unit power cost due to additional power requirements; financing and interest; and escalation until completion of construction.

8-10-70

Parsons-Jurden Corporation has made a preliminary engineering study of transporting the tailings from the railroad loading bins to a final disposal area in the Lax Lake area. The partial estimated capital cost of these facilities is $18,988,100. This estimate does not include the cost of land acquisition; higher unit power cost due to additional power requirements; financing and interest; and inflation until completion of construction. This cost estimate appeared to be higher than anticipated by Reserve. Therefore, Parsons-Jurden Corporation has been commissioned to restudy this problem in an effort to devise more economical methods of dry tailings disposal.

The pilot plant studies are being made to establish all the necessary changes in the concentrating flowsheet to accommodate the dry cobbing process. This work is estimated to be approximately 50% complete. It will require 30-60 days to develop all the necessary engineering data to be able to design the necessary changes into the production equipment.

Proposal #17

April 9, 1970
Revised August 10, 1970

The information now available indicates that the partial estimated capital cost would be $39,910,000 ($20,922,000 + $18,988,100) or $34,013,100 ($15,025,000 + $18,988,100) depending on the operating procedures developed by pilot plant work. The pilot plant work is not far enough along at this time to estimate operating costs.

8-10-70

PROGRESS: 70% complete.

TIMETABLE: Preliminary engineering data and cost estimate expected to be complete in approximately 90 days.

PROPOSAL #18

"SCREENING ORE AHEAD OF THE ROD MILL"

ENGINEERING STUDY BY: Trygve Hoff & Associates
[illegible]22 East 107th Street
Cleveland, Ohio 44106

DESCRIPTION: This proposal would reduce the top particle size of the tailings, thereby improving the efficiency of tailings processing.

The -3/4 inch rock would be screened just ahead of the rod mill to separate the crude into fine and coarse fractions. The fine fraction would bypass the rod mill and go directly to the cobber magnetic separators. The coarse fraction would be fed into the rod mill. Since this will result in a material reduction of rod mill feed tonnage, more grinding will be done on less rock. Therefore, the top size of the rod mill discharge would be reduced from the present 5/8-inch size to possibly as low as about 10 mesh.

PRELIMINARY EVALUATION: Since top size of rod mill discharge establishes the top size of the total tailings, a reduction in the top size of tailings would reduce the amount of water used to flow the tailings through the launders. This reduction could amount to as much as 30%. Thus, the size or amount of the hydroseparating, thickening, clarifying and pumping equipment needed can be reduced in proportion to the water reduction. Also, the amount of flocculents or coagulants would be reduced in almost direct relationship to the amount of water reduction.

While this proposal would not be significant by itself, it would materially aid in the functioning of certain other proposals in a number of ways. For one example, it would permit the use of lower water velocities in transporting water-borne solid materials.

PROGRESS: A screen was installed in the pilot plant March 28, 1970, and a series of tests will be performed to determine the value of this system and to establish the best screen size.

TIMETABLE: Trygve Hoff is already making preliminary studies of possible installations. Pilot plant tests are expected to require approximately 90 days.

April 9, 1970
Revised August 10, 1970

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PROGRESS: A screen was installed in the pilot plant on March 28, 1970, in the same general manner that space was available to install a similar screen in the production plant. A series of pilot plant tests were performed. 8-10-70

April 9, 1970
Revised August 10, 1970

Proposal #18

Under these space limitations, excessive water had to be used to wash the screen oversize ore into the rod mill. The density of the slurry could not be controlled during the rod mill grinding. Therefore, the amount of grinding performed by the rod mill was decreased, and the top size of the tailings was not reduced as anticipated.

TIMETABLE: Pilot plant tests showed that this screen would not function properly in the space available in the production plant. Therefore, preliminary engineering studies were discontinued.

8-10-70

Other methods of screening are being investigated in the pilot plant to develop means of controlling the size distribution of tailings.

PROPOSAL #19

"BY-PRODUCT USE OF TAILINGS"

ENGINEERING STUDY BY: Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts 02140

DESCRIPTION: This proposal is concerned with possible practical uses of tailings.

PRELIMINARY EVALUATION: The entire sand and gravel market within economical lake or rail shipping distance of Silver Bay--including all metropolitan areas on the Great Lakes--will be studied. Such potential uses as road construction, island airports, building concrete, glass and cement industries, as well as the use of these heavy sands as filter media, will be evaluated.

The fact that these tailings have a higher specific gravity than many other sources of sand or gravel is a detriment to tailings for many uses. However, in filtering processes where the filter media is back-washed, this higher specific gravity is advantageous to tailings. One such filtering process is water filtering as performed by municipal water treatment plants. Reserve's tailings meet the American Water Works Association specifications for municipal water filter media.

Many of the potential commercial uses of tailings have been examined over the years by Reserve personnel and others and found to be impractical. This is the first time that expert marketing consultants such as Arthur D. Little have been retained to make such a survey.

PROGRESS: This study has only recently begun and little progress has been reported to date.

TIMETABLE: Oral report on preliminary engineering studies and partial cost estimates are expected within 90 days. Written report expected approximately one month later.

April 9, 1970
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Arthur D. Little, Inc. submitted their report, "Analysis and Markets of Taconite Waste Products," June 19, 1970.

The four conclusions from page 3 of their report are as follows:

1. Sand or gravel products cannot be marketed along the lakes for prices exceeding $2.15 per ton. 8-10-70

2. The total market for sand and gravel from Reserve's Silver Bay operation probably could be about 1,000,000 tons, if the current market prices for sand can be met.

April 9, 1970
Revised August 10, 1970

Proposal #19

3. Total delivered break-even costs for sand and fine aggregate produced in the proposed operation at Silver Bay and delivered to the dock at the lower lake ports is estimated to be about $2.45 per net ton.

4. Sand and fine gravel products (-3/8") cannot be sold in the Great Lakes market area at sufficiently high price to pay both operating costs and transportation and unloading costs.

Arthur D. Little, Inc. estimate the total capital investment required to finance this project which would include all costs associated with construction, plus working capital preoperational charges and startup would approximate $1,900,000.

8-10-70

The operating costs for producing a sand product that will be acceptable by the construction industry is about 37¢ per ton. Practically, the ASTM specification for ready mix is required to market this product.

PROGRESS: This study is 100% complete.

TIMETABLE: No further work is planned.

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